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# INDIAN JOURNAL OF POWER & RIVER VALLEY DEVELOPMENT

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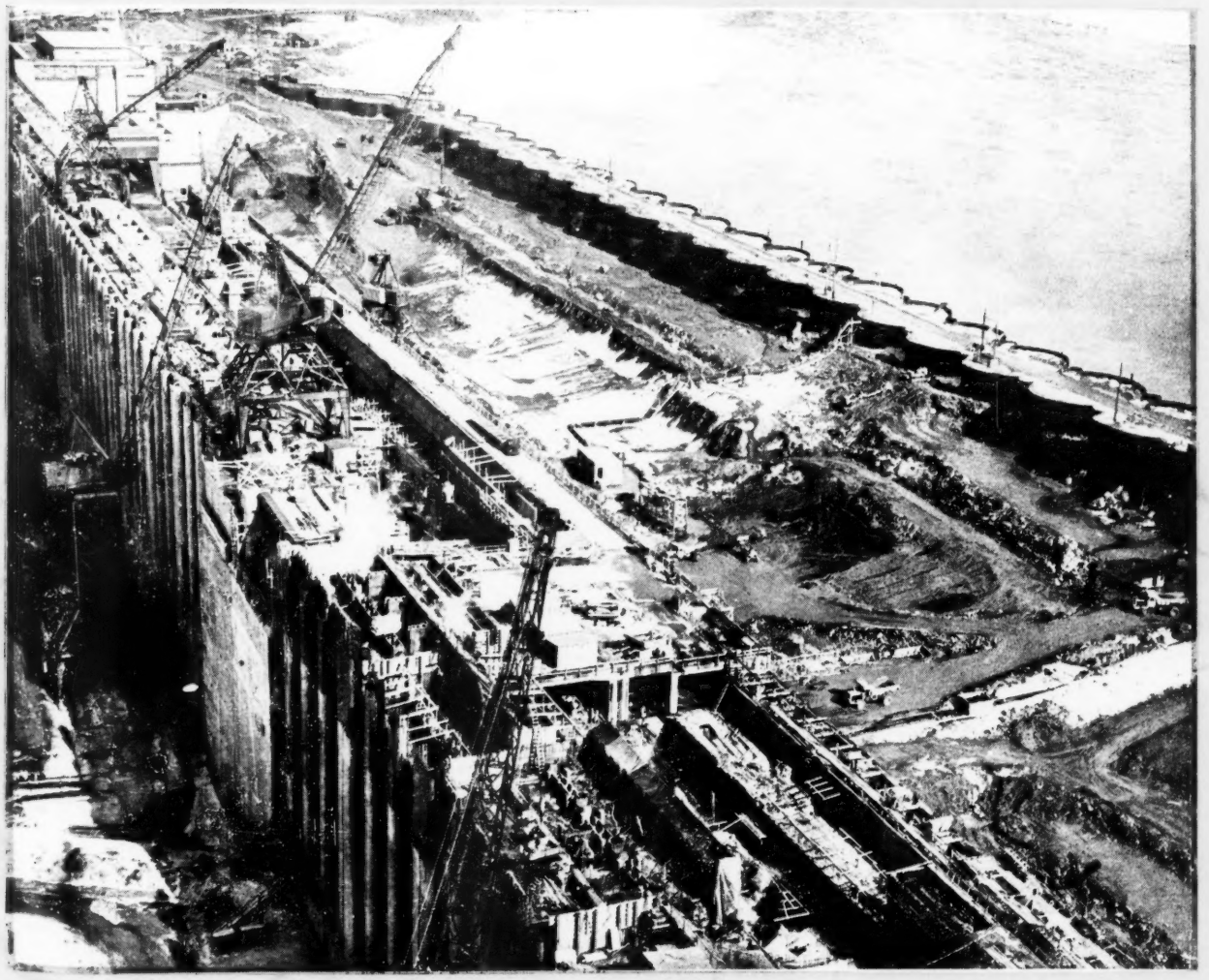

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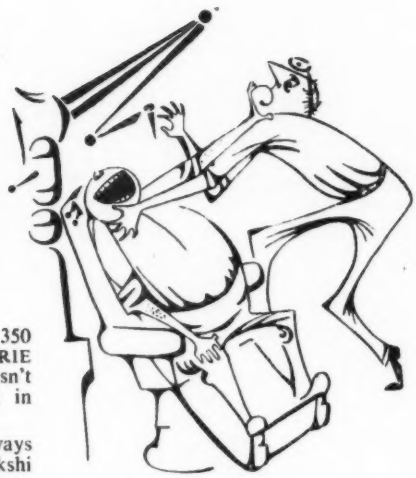

...ian 350
...S ERIE
machines are in the field. There isn't any project in which they are not in use...for example:

The Indian Army · The Indian Railways Damodar Valley Corpn · Mayurakshi Project · Kangsabati Project · Bhakra-Nangal · Hirakud · Delta Irrigation Project · Kosi Project · Kakrapara Project · Mahi Project · All the Ports in India · National Coal Development Corpn. Private Ltd · Hindustan Steel Private Ltd · Ganga Bridge Project · Chambal Scheme · Tungabhadra Scheme · Nagarjunasagar Project · Rihand Project Bhavanisagar Project · Neyvelli Lignite Project etc., etc... too numerous to mention.

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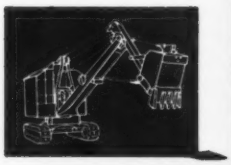
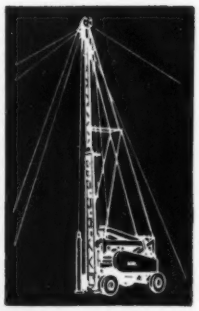
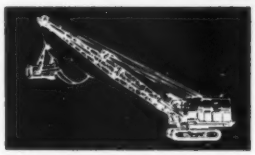


10 RB 3/8 CUBIC YARD EXCAVATOR



RB WATER-WELL DRILL



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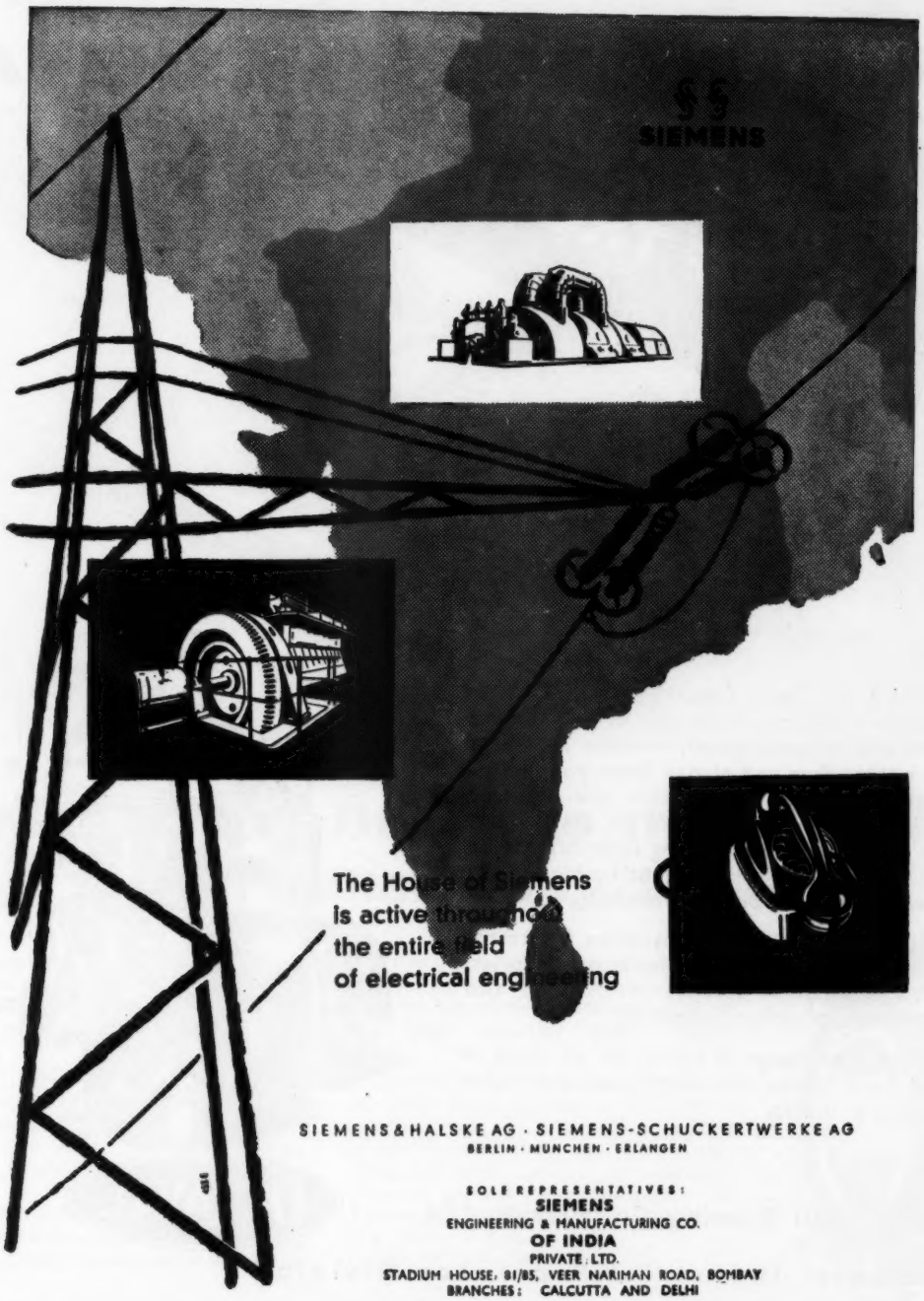


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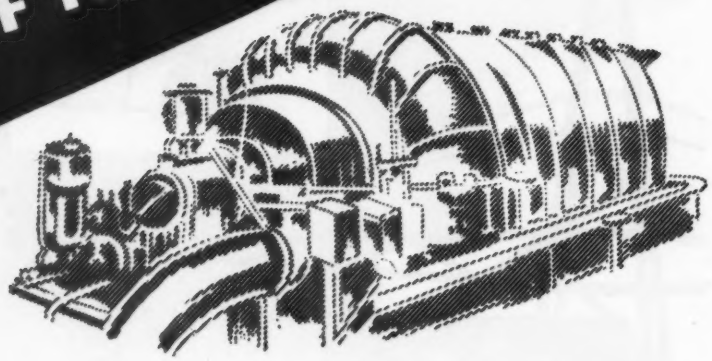

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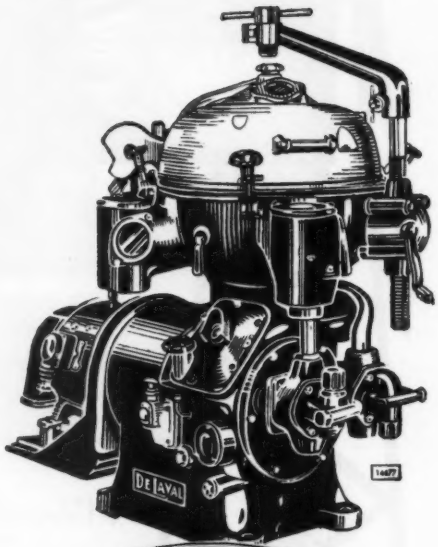


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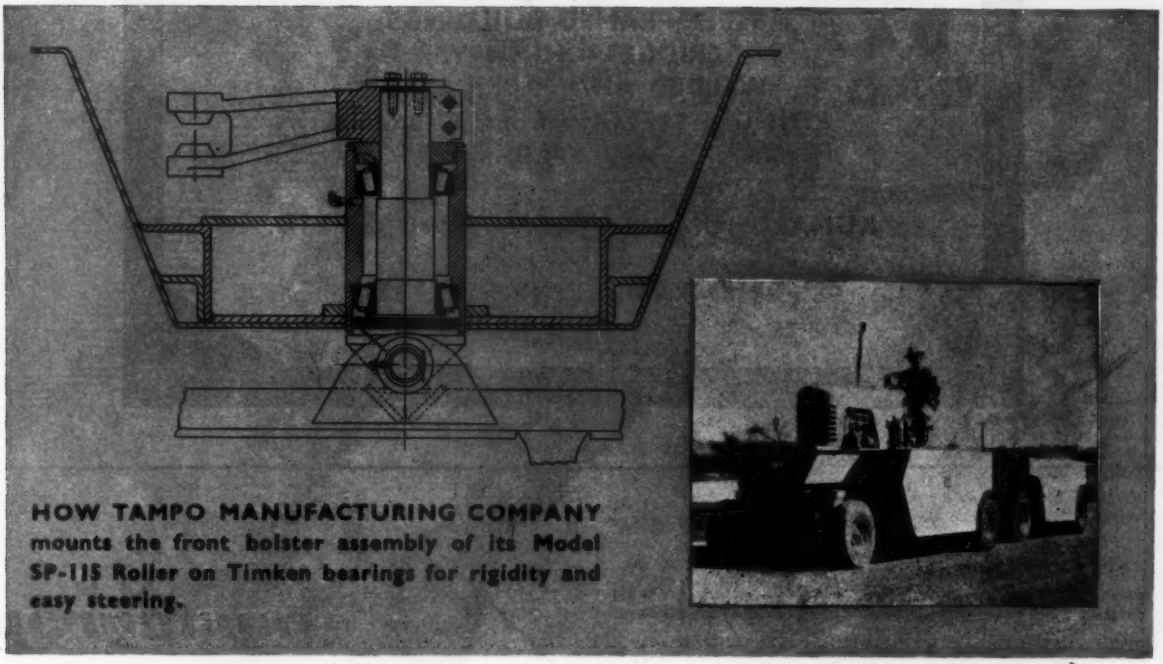

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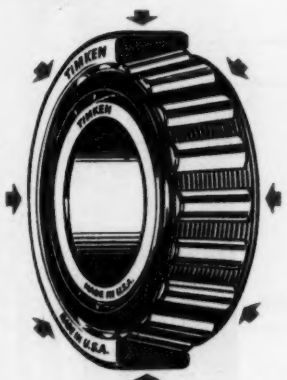


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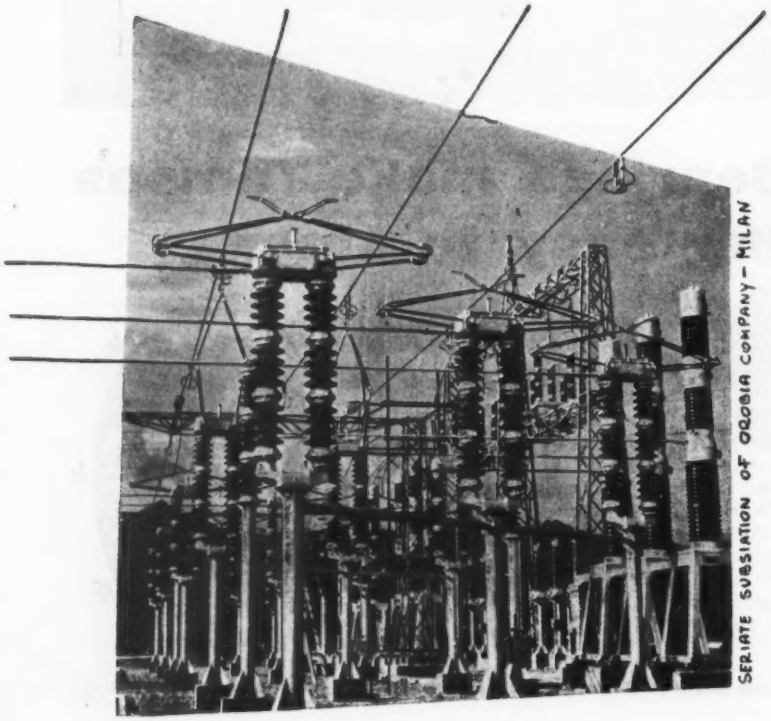


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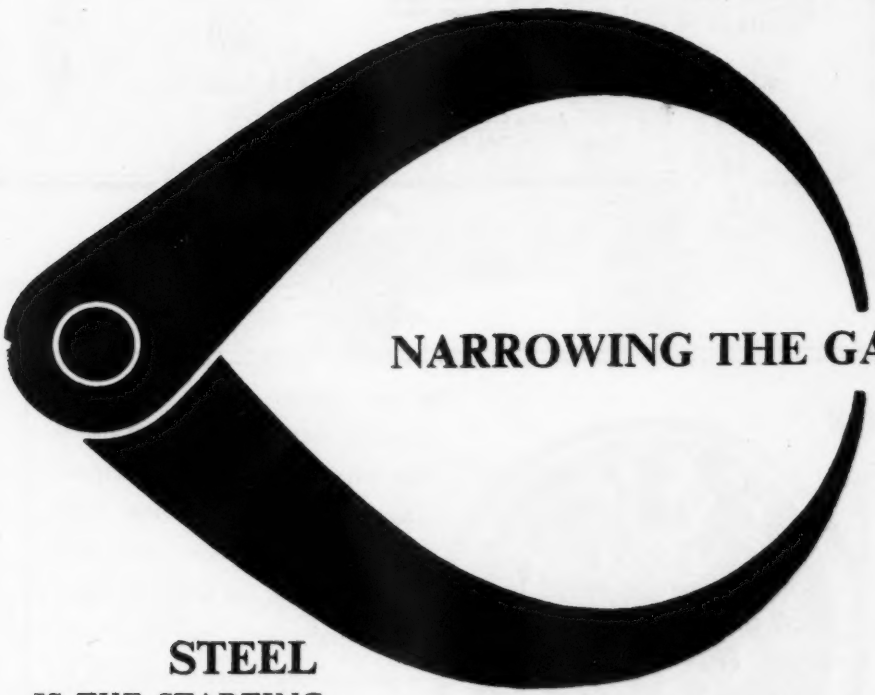

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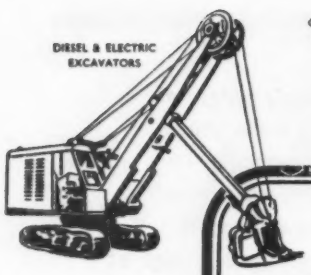


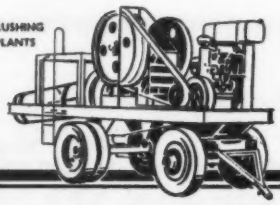


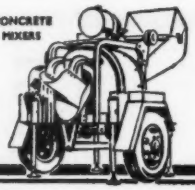


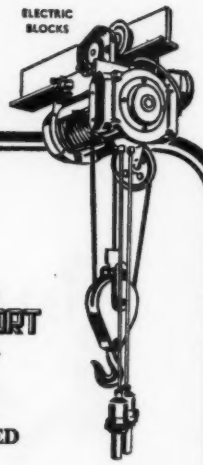


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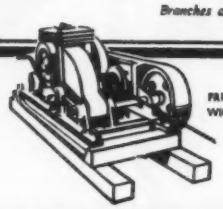


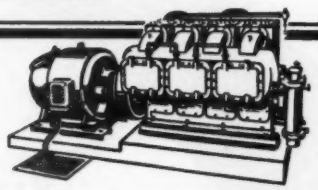


KA-6

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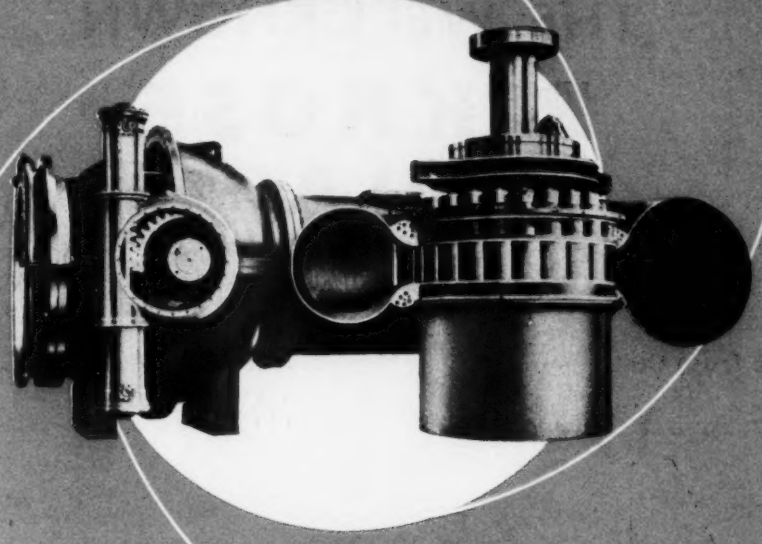

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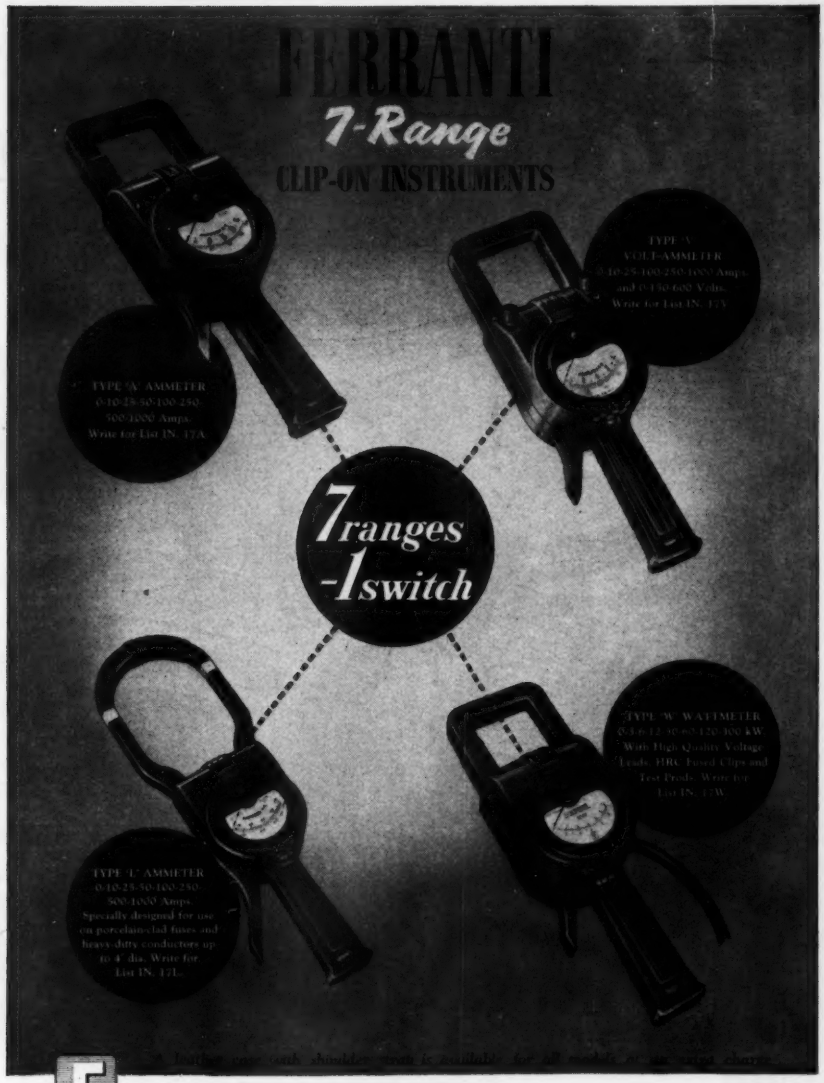


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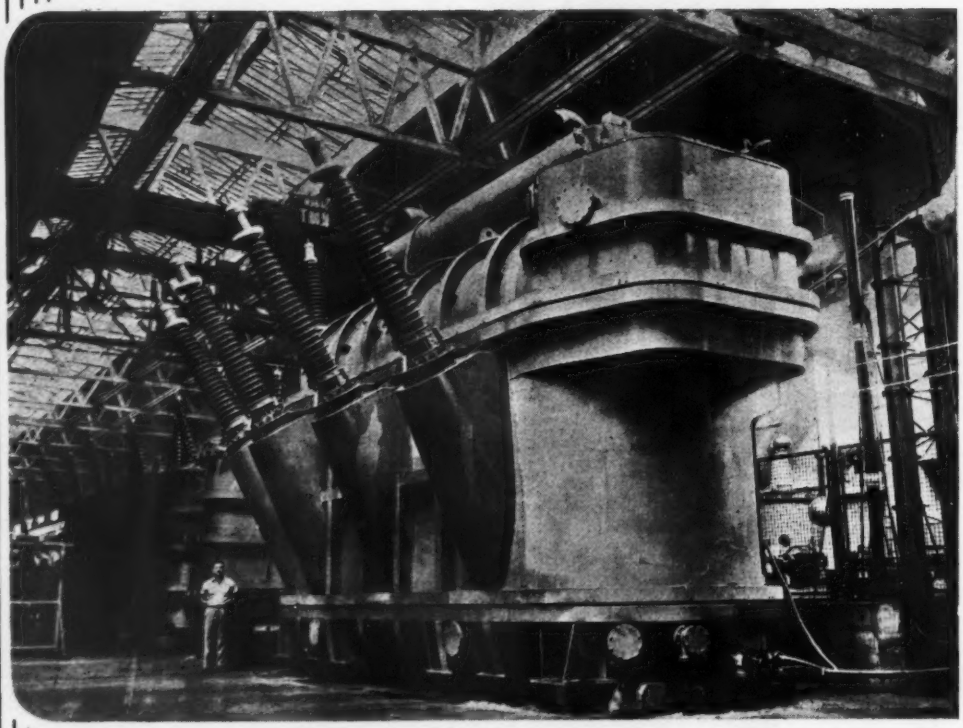

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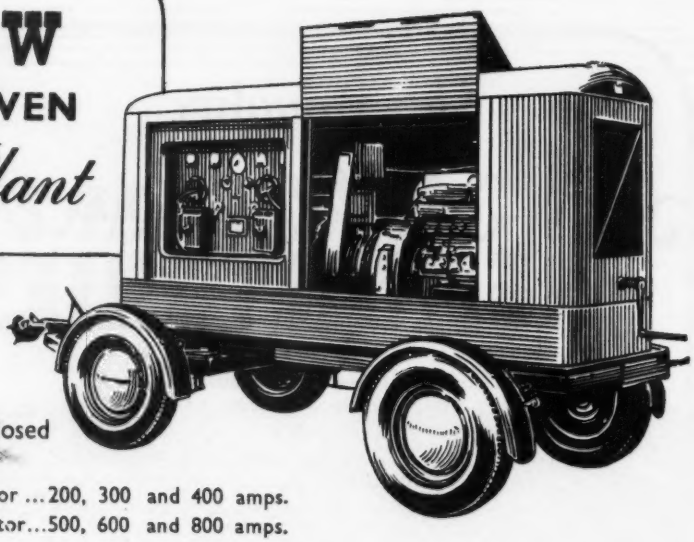

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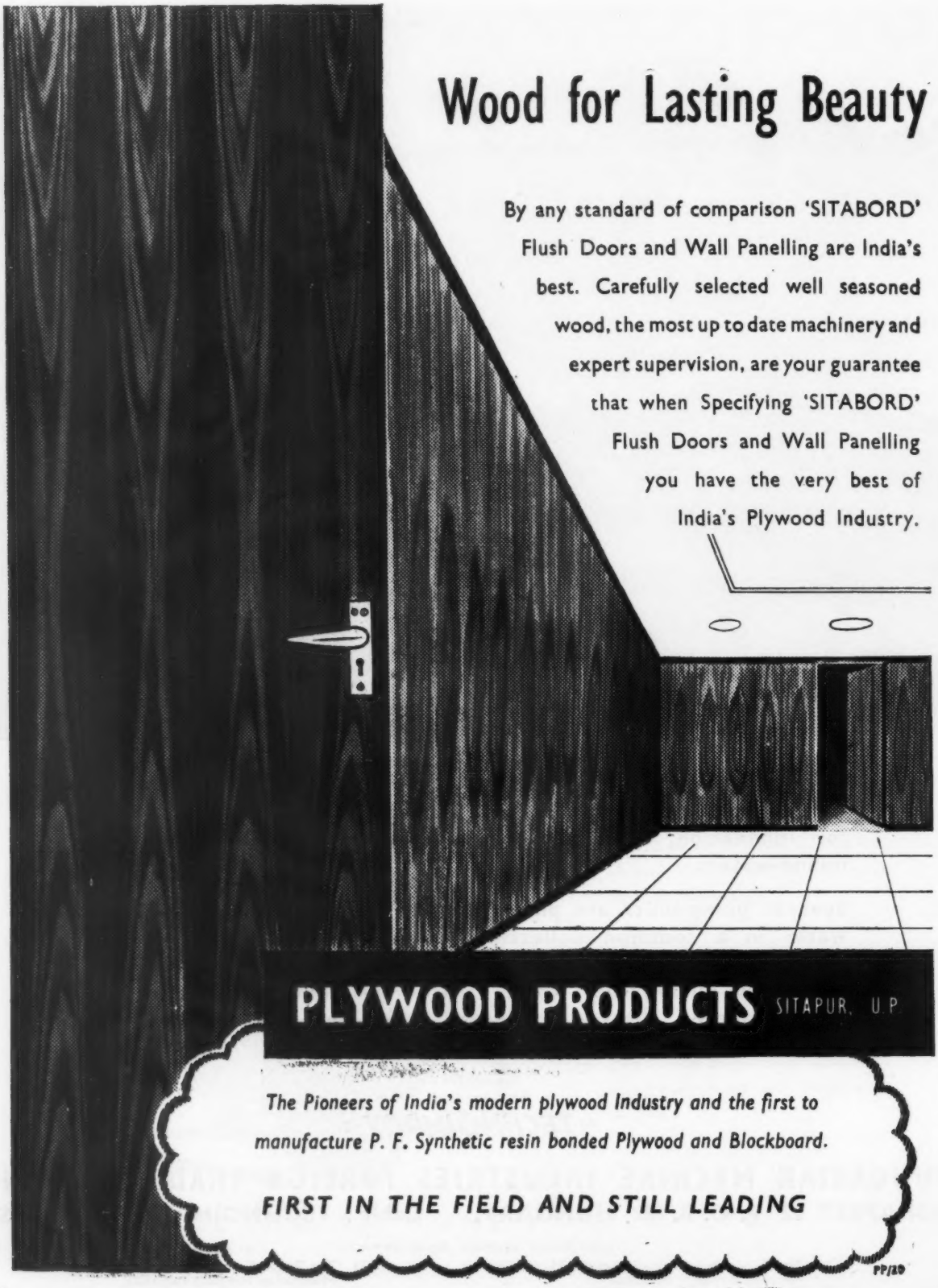

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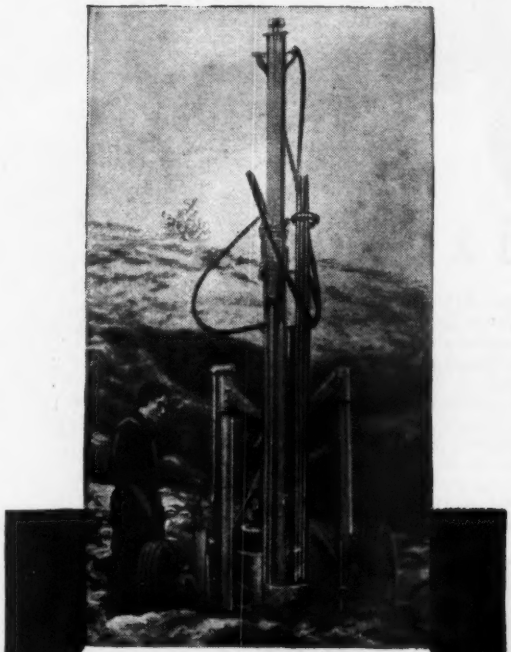

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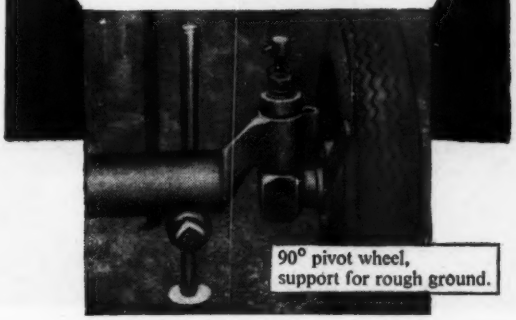

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**A MONTHLY DEVOTED TO DEVELOPMENT OF POWER & WATER RESOURCES IN ASIA**

Editor : K. K. Sinha

P. K. Menon : Mg. Editor

VOL. VIII MAY 1958 NO. 5


## CONTENTS


| | | |
|---|---|---|
| ATOMIC ENERGY DEVELOPMENT IN INDIA .. .. | *Jawaharlal Nehru* | 1 |
| POWER POSITION IN THE STATE OF MYSORE .. .. | *J. L. D'sa* | 4 |
| MAJOR IRRIGATION PROJECTS IN MYSORE STATE .. .. | *M. V. T. Iyengar* | 7 |
| COMMISSIONING OF TRANSFORMERS .. .. | *R. N. Ganguly* | 9 |
| RIVER VALLEY PROJECTS AND LAND ACQUISITION .. | *P. R. Ahuja and C. K. Kochukoshy* | 15 |
| DRAINAGE STUDY OF LOWER DAMODAR VALLEY—VI .. .. | *Satyakam Sen* | 19 |
| NUCLEAR POWER STATION AT BERKELEY .. .. | | 27 |
| LETTER TO THE EDITOR .. .. | | 30 |
| REPORT ON CHAMBAL PROJECT .. .. | *Editorial* | 31 |


**The coming issue :**

Water Power Development in Africa *by* Robert C. Keith ; Major River Valley Projects in India—A Report of Progress ; Gauging Work : Its Significance and Progress *by* R. L. Phansalkar, B.E., M.I.E., M.I.A.H.R. B.S.E. (I) ; The St. Lawrence Seaway Project : an Outline ; Prospects of Electricity Development in Europe—Editorial


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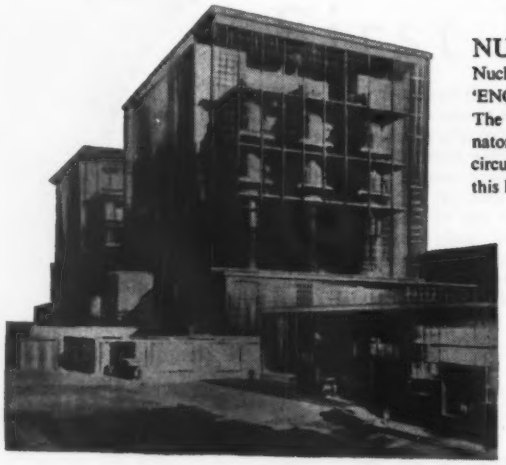

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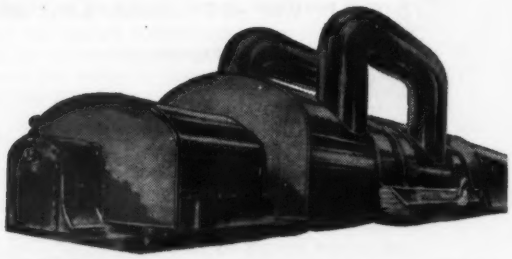

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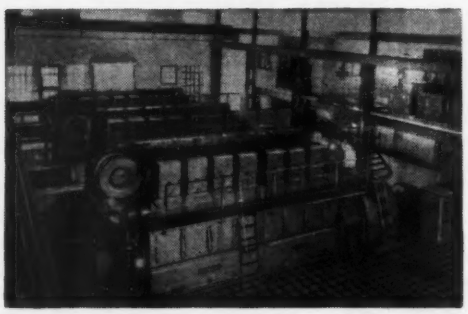

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# Atomic Energy Development in India

*The present article is based on the two speeches delivered at the Lok Sabha (Parliament) in April this year. As the subject is growing in importance the perspective as seen by the Government of India is presented here for general information Shri Nehru needlees to say, has taken an active and continued interest in the development of atomic energy in India.—Editor.*

By JAWAHARLAL NEHRU

It is many years ago when we first formed the Atomic Energy Department. Before that it was called something else—because we realised even at that early stage the importance of this. Normally speaking, the development of atomic energy has taken place in the countries which are industrially advanced. They have the resources for it. It is somewhat unusual for a country like India which is on the threshold of industrial advance, and is struggling to bring about what might be called the industrial revolution here, which took place a hundred or more years ago elsewhere—it is rather unusual for a country in this position to launch out into an atomic energy programme. We did so not because we wanted to show off that we have got something big, but because of the definite realisation that this was of the highest importance, looking at the future. We were on the threshold of the atomic age in the world. For us, this had overlapped, if I may say so, with our being on the threshold of the industrial age in India. But it is impossible for us to go through the slow processes of the industrial age, having arrived at somewhere far behind, while the other countries have gone on the atomic age. So, we thought that we must give thought to this matter.

Fortunately, we had able nuclear scientists. Otherwise we could not have done it. It is not a question of money. Money is the least part of it. Indeed in anything worthwhile that has been done in the country, let us remember that, though money is important, it is of the least importance compared to trained men. That is the real thing. It is they who produce things and money.

### Power Supply

But there was another aspect of this question which led us to think in terms of atomic energy development and this was the question of power supply. It is well known that you can almost judge of a country's progress by seeing how much power it produced and consumed. Our sources of power, thermal, and hydro-electric are there, of course, but the principal source of power in India still continues to be cowdung. It is well to remember this. People do not realise it. I forget the exact figure but probably 80 per cent of the power—or, may be—used in India comes from cowdung. That is of course the primitive state of our economy.

The other day, my colleague who was then the Minister of Irrigation and Power, spoke about the untapped sources of power in India. Of course there are untapped sources, very big sources. But I think he was somewhat optimistic about those untapped sources. Not that he was not justified in being optimistic. You can take either view.

For instance, one source was the river Brahmaputra, more especially at the place where it takes the turn to India from Tibet. It is a potential source of enormous power. But in order to reach that turn of the Brahmaputra there, it would require enormous efforts on our part. It is relatively easier perhaps for the Tibetan authorities and the Chinese Government to reach there: it is more in their territories than ours. Anyhow, it is difficult to get there and having got there, it is difficult to get out the power that you produce there.

But apart from that, the normal calculations about the coal and hyrdo electric power depend upon how much we use and at what rate we consume. For instance, if we consume this power at the present rate which is of course a very low rate, it may last us 200 or 300 years or more. But if we consume at the rate of the USA today, then all the potential power will last us 30 years and not more—may be 35 or 40 years. Of course we are not going to consume at the rate at which the USA consumes because we cannot. We may arrive at some middle figure between this and that.

But the point is that we have not got inexhaustible supplies of power in India and that was one reason among many others which forced us to consider the possibility of using atomic energy in future as power for civil purposes.

This was mentioned for the first time, I think, by the Chairman of our Commission, Dr. Bhabha, who has been speaking at some length about this subject. He spoke, I think, lat year at Dublin at the British Association meeting too, working out the figures. People are somewhat doubtful and credulous about the feasibility, about the economic aspect of it. He showed even then, that in places far removed from the coal fields or the places where hydro-electric power is produced, this was a feasible proposition. It was not feasible in the economic sense right in the coalfield because coal was cheap there.

But ever since he made that calculation, other developments are taking place, which indicate the probability of this power being produced from atomic energy in a cheaper way, and it seems now quite a feasible proposition in most places. I have no doubt that further advances will make it more feasible still.

In a country like India whose power sources are very limited at the present moment, it is of the highest importance to get something like that. The use of atomic energy for peaceful purposes is far more important for India than, let us say, for the United States of America, because they have got tremendous other sources of power, and cheap power. So, not only for the obvious reason that we are on the new source of energy which is going, probably, to transform world conditions in the future, and therefore we should know about it,—not know it by reading text books from other countries, but we ourselves, our scientists, discoverers and research workers should know about it; that is important—but apart this, it is important because we hunger for more power in this country. Many are making demands for electricity there and electricity here, which are completely legitimate and understandable. You can really measure the advance of any part of the country by the electric power available there. Because of that too, and looking into the future we thought it desirable to carry this work on.

### Universities and Nuclear Physics

What is this atomic power? This is a part of nuclear physics. Nuclear physics is and should be a part of the basic training it physics in any university. But, if we want every university in India to take up this atomic energy work in detail, well, they just have not got the equipment or the personnel, and we will spread out our very limited resources in trained men as well as equipment, with the result that there will be no result at all—just spread out fine lectures delivered here and there. Therefore, we have to concentrate our available talent, our available equipment which is exceedingly expensive etc.,—these reactors—in this Atomic Energy Establishment that we have got, expecting that the universities will do a good job of work in teaching nuclear physices and thus supply people from there to these specialised agencies of the Atomic Energy Establishment, where they can do higher work, and that specialised agency again supplying their trained men for work in the universities, for teaching work and the rest.

I am laying stress on this because, first of all, it is very important that our universities should have up-to-date teaching and equipment for nuclear physics. That is the basis out of which every other thing will come. And, they have not got it today. They are ambitious—some of them—and want to do atomic energy work. I like their ambition, but they have not got the facilities for it. They make demands on the Atomic Energy Commission: "Give us this equipment; give us that; give us lakhs and lakhs of money". I want to make it clear that we cannot, financially or in terms of personnel, spread ourselves all over India in regard to higher atomic energy work. But what we do is for special research projects. The Department gives money and, may be, supplies some equipment too if necessary.

So far as the study of nuclear physics is concerned, which we should like all universities is India to have in an adequate degree, that is not the function of the Atomic Energy Department as such. The University Grants Commission should look into it and do it. We must not get mixed up in the two, because that may mean lack of success at both ends.

### Atomic Energy Development

Now, in this Atomic Energy Establishment, may I say—of course, it does not need saying, perhaps, but I should like to repeat it—that we are not in the slightest interested in atomic bombs and the like, except in so far as we wish to avoid them and not be targets for them. Anyhow, all our work on atomic energy is, for the peaceful use.

We have drawn up some kind of a long range plan which is not complete, in regard to the development of atomic energy. Even during the last year the programme has expanded rapidly. The scientific and technical staff of the Atomic Energy Establishment, which is the heart of the research and development activities of the Department, now exceeds 600. A year ago it was 320. These figures only include graduate scientists and engineers and those with higher qualifications. It is expected that this number will increase by another 300 during the current year — that is, it will come to 900 senior scientists.

To feed this recruitment, the Department has started a training programme from last August, admission to which was made after a very rigorous selection by interview. The total number of applicants exceeded 7,000. Of these, 1,400 were called for interview, and over 1,100 actually appeared. The number selected was about 200 of whom about 176 will finish their course. These trainees are given not only courses in basic physics, chemistry and mathematics to fit them for the more advanced courses which come later in the year, there are tutorial classes for small groups of students. This training is necessary chiefly because the training received in the universities was found not to be adequate, and it is our desire that the preliminary training should be made adequate in every university, instead of some universities having inadequate training there and wanting to do some direct atomic energy work also, which also will necessarily be inadequate.

Now, so far as the scientific work of the Trombay Establishment is concerned, this has also increased in breadth, variety and intensity. Our first reactor is called Apsara the Water Nymph.

It is a suitable name because it is called, I think, "Water Cooled Reactor". This Apsara reached criti-

cality, as the phrase goes, for the first time on August 4, 1956. It was worked at very low power levels till the end of January, 1957, so as to check its operations. Since then its utilization has increased rapidly. Demands on the use of the reactor become so great that it is worked on two shifts a day, and it is expected shortly to go into three shifts operation. Requests for irradiation of biological sepcimens and radio isotopes from various centres in India have been met to a large extent, and an Isotope Division has been established for which special facilities are under construction. This is expected to produce radio active iodine, radio active phosphorus and certain other isotopes required for biological and medical investigations. When the Canada-India reactor goes into operation, the full range of radio-active isotopes including radio cobalt will be produced. A new radio chemistry laboratory has been constructed which is designed to deal with radio active substances like plutonium and the fission products. Some of these substances like plutonium are so toxic that a maximum permissible dose for ingestion into the system is much less than ten-millionth part of a gram. More of it will be dangerous. Therefore, extremely drastic precautions have to be taken in handling such substances. Most of the work with plutonium is done in glove boxes which are now being made at Trombay. These glove boxes—the hands never touch them. The gloves are inside and manipulated by hands from outside.

This work with radio-active substances requires a constant watch to ensure that the workers are not exposed to dangerous radiation levels. All the necessary instruments for health protection are now being made by The Health Physics Instrumentation Division. Indeed, most of the electronic instrumentation used in the Trombay establishment or the Atomic Minerals Division is now made in the Establishment, especially in the Electronics Instruments Section. This saves us a good deal of foreign exchange.

The Health Physics Section has organised a Film Badge Service for the workers not only in Trombay but elsewhere in India. Each person wears a film badge and this film in the badge is processed weekly and a record kept of the radiation dose received by each worker. This service is available to hospitals in the country where radium and X-rays are used at a nominal charge and it is being availed of by a large number of hospitals and other institutions not connected with atomic energy.

### Canada-India Reactor

Now, the construction of the Canada-India reactor made progress during the year though difficulties were encountered with the steel shell. The top of the steel shell is a hemisphere, some 150 feet in diameter, and is one of the largest containment vessels in the world. It is now expected that the Canada-India reactor will be ready towards the end of 1959. When this reactor goes into operation, India will possess one of the best isotope producers in the world, with which it will be possible to produce all neutron-induced isotopes including radio cobalt.

A storage block for the used fuel elements is being designed so that the intense radiation emitted by them can be used for studies on the effects of radiation on the preservation of food and other biological experiments. Studies are also being made on the use of radiation for killing weevils, insects and other organisms which lead to the destruction of foodgrains in storage. The construction of the uranium plant for producing uranium metal of atomic purity was undertaken during the current year, and the building is nearly complete. A laboratory plant for converting this uranium metal into fuel element for the Canada-India reactor and other natural uranium reactors is also under construction at Trombay. This will have the necessary facilities for canning the fuel elements in aluminium cans and other minerals such as beryllium and zirconium. The Department is in close touch with, and carefully follows, all developments in this rapidly advancing field all over the world.

The scientific personnel of the Department have attended scientific conferences, visited laboratories and atomic installations and established contacts with scientists in other countries. The Department has friendly co-operation with similar organisations in all those countries which are most advanced in this field. A number of distinguished scientists and mathematicians from Canada, France, Japan, Poland, the Soviet Union, the United Kingdom, the United States of America, Yugoslavia and other countries have spent varying periods at the Trombay establishment and the Tata Institute of Fundamental Research, giving seminars and lectures.

We propose to produce our own heavy water to begin with in connection with the fertiliser plant at Nangal. Sometimes ago I made a statement in regard to the constitution of the Atomic Energy Commission. It has been constituted by a resolution of the Government of India. About two years and a half ago, in August, 1955, there was the first great conference on the peaceful uses of atomic energy in Geneva. It was rather a remarkable conference on this new subject and a very successful one. It was presided over by our own eminent scientist. Dr. Bhabha. Now, a second conference is going to take place in Septmber this year at Geneva. Meanwhile, the International Atomic Energy Agency has been established. This came into force in July 1957. There are 62 member states in it. The first general conference of the Agency was held in Vienna in October 1957.

### Reply to points raised during discussion

I shall now endeavour to reply in brief to the points raised. The last speaker made a suggestion that there should be a separate Ministry for Nuclear Research, so that decisions may be taken quickly and at a higher level. Broadly speacking, I do not know any higher level here than Government and the Prime Minister and I do not know how the creation of a Ministry would expedite any decision or make working more easy. As a matter of fact, it was with this very purpose, that the work of this Atomic Energy Department should no get tied up in the normal routine of Government, that the Prime Minister here, and sometimes in other countries also, has directly taken charge of this. So, I can assure Shri Bharucha that whatever other failings may be there in this Department, it does not suffer, as other Ministries often suffer, from delay. Things are done pretty fast.

Secondly, Shri Bharucha laid great stress on not wasting our energy on collecting useless knowledge or

on experimenting about all manner of things, but said that we should rather concentrate on special objects of enquiry which might prove useful.

To begin with, we do necessarily concentrate; we cannot help it. But, when Shri Bharucha refers to useless knowledge, I think, he is on some dangerous ground. There is always the same argument usually between scientists and non-scientists, industrialists and others as to what is useless knowledge and what is not, what is pure science and what is applied science. Everything in applied science would normally come out with some research in pure science. You cannot divide these. Anyhow the fact is that we do concentrate on specific things.

But some of the matters he referred to are research in biology or medicine or other things. That type of research is not primarily the work of the Atomic Energy Department. The Atomic Energy Department produces the isotopes, equipment etc. for it. And, this proposed types of research should take place in a hundred establishments in India wherever it can be in hospitals, in agricultural institutions etc. So, that is the place.

I entirely agree that a tremendous field for research is open and should take place. The Atomic Energy Department will help in supplying the isotopes and the equipment which they are making. But, I may add that in addition to this, although it is not in a sense the primary work of the Atomic Energy Establishments, as a matter of fact, they do research work in these very fields which Shri Bharucha mentioned, whether it is agriculture or biology. They do it and they will continue to do the same but they cannot spread themselves out over all this. It should really be done by a host of people all over the country in other establishments.

Now someone asked about the Government taking a policy decision about the construction of power station. In a sense, the Government has taken a policy decision but it is naturally subject to two or three factors. the feasibility of it and the finances. It is not that we shall do this on this particular date. *We have taken this decision and we intend to do it and will certainly do it.* This exact date, the location, the feasibility have all to be considered in terms of other factors.

### Precautions

Dr. Sushila Nayar warned us about the disposal of waste. I want to assure her that so far as Trombay is concerned, there is no waste of that type. The criteria laid down for the future are so strict that I am informed that there will not be the slightest risk. Indeed one tends rather to take extra measures of safety. I am told that the water that comes out of this after all this is so treated that it is, broadly speaking, less radio active than the normal amount of radio activity in the water we drink. The amount of precautions taken is very great indeed. It is said that the workers engaged in nuclear research work and such other industries are better protected than probably in any other industry in the world.

The Atomic Energy Establishment is thinking of providing scholarships for nuclear engineering at the Roorkee University. This might be done elsewhere too later on.

We have at present in Trombay a group working on the design of a power reactor of 10-20 mW with beryllium oxide as a moderater. We are also considering making a strong effort on research for fusion reaction. We have not quite started on it, but this will depend on a number of factors and if we feel that from researches on this we are likely to get fruitful results, we may take it up.

Our atomic Energy Establishment is connected, or its chief scientists are connected, with a large number of establishments in India. There are many liasion committees and the like. They are connected with the universities. I shall certainly be happy if this connection grows.

A complaint has been made that enough information has not been supplied to the Parliament. It is rather difficult to know what type of information might be supplied. I may inform the House that Dr. Bhabha and I where discussing this very subject as to what should be put in this pamphlet for the House. We had to draw the line somewhere, in the sense that it should not be too technical, Some hon. Members of the House may certainly understand all the technical implication but it was not meant for an isolated Member but for every one. I told Dr. Bhabha: "Please do not make it too technical. Otherwise it will be above the knowledge of many Members." Even the Member in charge might get into difficulties. It is not because one wants to keep anything secret. There is no secret about it so far as we are concerned. But there is the difficulty about the technical aspect. Shri Bharucha, having made some special study, no doubt understands much more than many others. Anyhow, I shall be very happy to provide any kind of information that is in our power.

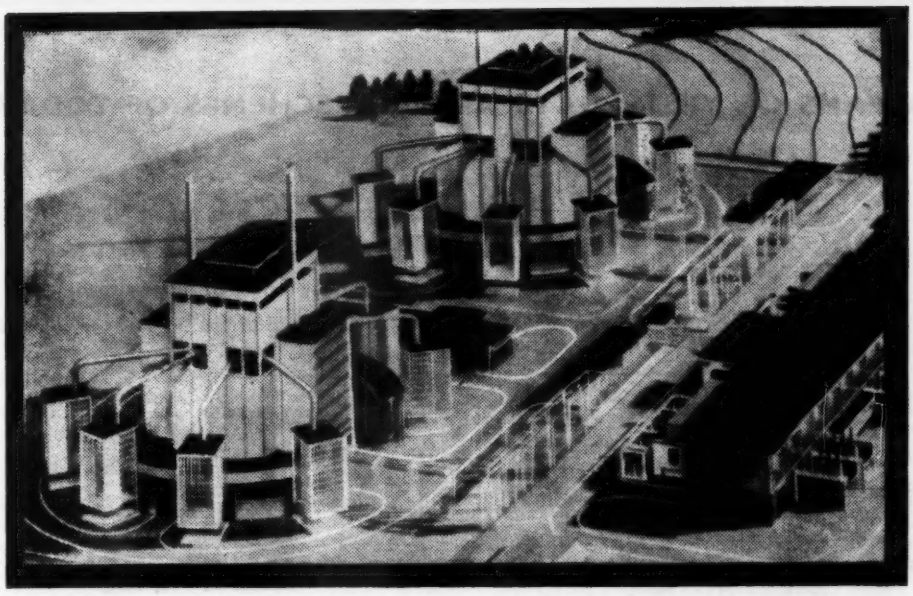
Shri Nayar said something about the production having gone down in the plants in Kerala. Apart from the fact that the previous production was of all the three plants, the third plant is still not functioning. There has been much difficulty because of this. A bit of the old Madras State went to Kerala and that bit of the old Madras State had one of these plants. Even, now, after a year's effort, there is no full agreement. between Madras Government, the Kerala Government and the Atomic Energy Establishment about the new set-up, as to who should provide the additional director and what should be the shares of eacn Government. I think that we are now on our way to an agreement. Dr. Bhabha visited Trivandrum for this purpose. So, this has created some difficulties in settling down. I believe that sometime in the past there was also a strike which made a difference.

Previously it was in the old Travancore-Cochin State. One part having gone to Madras, that Government naturally wants its own share in this thing, in the directorate and in the finances.

### Cost of Atomic Power

There is one thing more which I may mention. The

*Continued on page* 6



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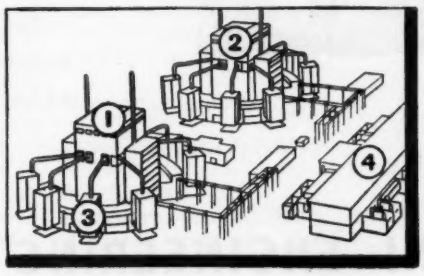


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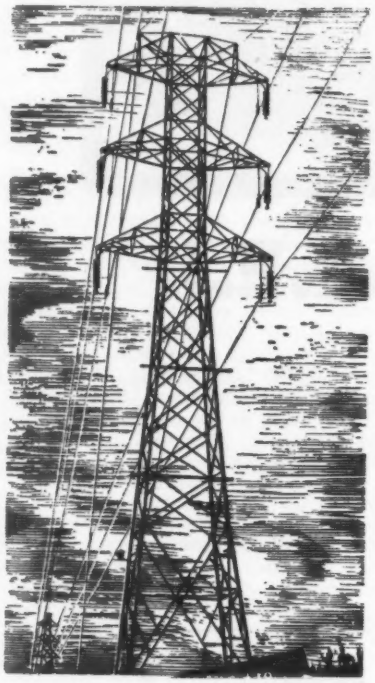

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# Power Position in the State of Mysore

By J. L. D'SA

Mysore is singularly lucky in possessing the greatest of potentialities for hydro-power as well as an equal amount of resources for starting key industries for which electricity is vitally required. Being conveniently situated on the Deccan plateau with a mean height of 2,500 feet above sea level, important rivers flow across the heart of Mysore to both the Eastern and Western seas with excellent water falls in their courses. These falls form natural sources of hydro-electric power. Mysore is thus one of the few States in India where power potential is available in plenty. The Government of Mysore have from the beginning been active in utilising as much active energy as was required to meet the needs of industry and were in fact till recent times in advance of actual requirements of industry.

The pioneer of all hydro electric stations in the East was Sivasamudram, where the waters of the mighty Cauvery were utilised to generate 45,000 k.W. of electric power, while falling over a height of 300/400 feet. Thanks to the farsighted policy of that illustrious statesman, Shri K. Seshadri Iyer, this station was harnesed within the State's resources and power was made available to the remote corners of the State by the year 1902.

One of the richest gold mines of the world, the Kolar Gold Fields, formed part of Mysore State and the organization started by Messrs. John Taylor & Co., England, was the main power consumer. Messrs. Binny & Co., Messrs. Sirur Mills and other textile organisations along with the Gold Fields and the Iron & Steel Works at Bhadravati soon proved to the electrical engineers, that they had to think fast in finding further potentialities and harness them in advance of requirements of the Industry. The big reservoir at Krishnarajasagar was found to possess enough water in storage to feed one more power station and after a great amount of recannoissance, survey and engineering activity, a second generating station at Shimshapura was built. Here the waters of Cauvery are diverted and utilised to generate power to an extent of 17,200 kW. over a drop of 610 feet. This generating station is on the banks of the river Shimsha and water is led from the main reservoir at Sivasamudram and is turned off into the river Shimsha after turning the water wheels. Thus the generating capacity of Mysore rose to 62,200 kW. by 1940. But the addition proved too inadequate. Bhadravati Iron & Steel Works, the chief industrial centre in the Northwest of Mysore, known as The Birmingham of Mysore, was the main consumer and the demand of power by the Iron Works was too heavy on both the stations, so that, should power be made available to all people along with other small industries, a third generating station was immediately found necessary. This set in the foundation for the start of the mammoth Mahatma Gandhi Hydro-Electric Project at Jog Falls. The Project utilises 1,200 cusecs of water of the Sharavati river falling over a grosshead of 1,205 feet. The power available out of this Project is 120,000 kW. and this Project put Mysore's production of electricity at 179,000 kW. (this was so as Sivasamudram's capacity was reduced to 42,000 kW).

With the country's achieving independence in 1947, the demand for Rural Electrification, Power Supply to Irrigation Pump-sets and the setting up of further industries grew and the surplus power started to dwindle. A stage has now been reached where the total of 179,000 kW is found to be inadequate. The cement factory, paper mills and the Steel Plant and Pig Iron Furnace brought up the demand of power at Bhadravati itself to the level of 40,000 kW. All taluk headquarters in the former State of Mysore were electrified. The supply position at the end of 1955-56 was as follows:—

| | |
|---|---|
| Generating capacity | .. 179,200 kW |
| *Demands due to Industries:* | |
| Kolar Gold Fields | .. 25,000 kW |
| Bhadravati | .. 40,000 ,, |
| Bangalore—H.A.L., Binny & Co. Bharat Electronics, H.M.T., I.T.I., etc., etc. | .. 20,000 ,, |
| Industries at other places like Davangere, Harihar, Mysore, etc. | .. 10,000 ,, |
| Other power loads throughout the State | .. 30,000 ,, |
| I.P. Sets, domestic and other demands | .. 75,000 ,, |

These demands have necessarily a diversity factor which is found to be as high as 70% to 80%.

As a result of our participation in the Tungabhadra Project (Right Bank) a tentative share of

9,000 kW of power could be made available to the State by March 1958. Of this, half the power is now being utilised to augment the resources in the former State of Mysore, the other half being got ready in the course of a few months. With the integration of Raichur District, the Tungabhadra Left Bank Power Project came over to Mysore for implementation. It is hoped that this station will come into operation early in 1960 with an installed capacity of 18,000 kW to be increased by the end of the Second Five Year Plan by another 9,000 kW.

Mysore State began to grow as a result of the States Reorganisation. Bellary District was added on 1-10-1953. The Districts of Karwar, Dharwar, Belgaum and Bijapur of Bombay State, Raichur, Gulbarga and Bidar of Hyderabad State, Coorg, South Kanara and Kollegal of Madras State were along with old Mysore integrated to form the Greater Mysore on 1-11-1956. Even prior to integration of States the Electric Department was actually engaged in investigating possibilities of increasing the power potential. In brief the States Reorganisation has brought with it the following further commitments :

(*a*) An additional 41,033 square miles with a population of 95,52,794 is added on.

(*b*) The new regions added except for the Tungabhadra Left Bank Station which is under active execution and which by 1960 will give us an additional 18,000 kW have a total installed 5660 kW of diesel power.

(*c*) The per capita consumption of old Mysore State as compared to the integrated is 64.90 (integrated areas being 4.30).

As most of the areas of the old Mysore State have been served by electricity, the State Electricity Board will have to concentrate in extending lines to the remote corners of the new State, in particular the northern areas in order that when power is made available, the integrated areas will also be benefited though to a smaller extent than the old State of Mysore.

Of the Projects that are under active execution in the old State, special mention has to be made of the Bhadra Reservoir Project and the Sharavati Valley Hydro-Electric Project. The waters of the Bhadra Reservoir which is essentially an irrigation project are being so regulated as to enable the State to generate a 25,000 kW firm power with two stations—one on each side of the banks. Even with the addition of the above two Projects, the position of power availability in the State will still be very acute by 1960-61. The tempo of industrial expansion has thus prompted the State Government to venture on another gigantic project named Sharavati Valley Hydro-Electric Project. This envisages utilising the waters of the river Sharavati at a place three miles below the existing Mahatma Gandhi Hydro-Electric Station at Jog Falls. The ultimate capacity of this Station as at present designed is 891,000 kW consisting of ten units of 89,000 kW each. The Project has already been taken on hand consequent to inclusion of the same in the Second Five Year Plan. It is hoped that by the year 1961-62 the first stage of the Project will be ready enabling the State to have 2 units or an additional 1,78,200 kW to cater to the needs of the industries.

A double circuit 220 kV. super high tension line is proposed to be constructed from the station site to Shimoga, whereat a high tension Transformer Staion is being put up. This Station will be a key point for all the high tension network of the State of Mysore.

The department of electricity has been doing its best to keep pace with the requirements of various industries, which for the present have been going up by leaps and bounds. It is hoped that by 1961-62 the generating capacity of Mysore State will be of the order of 423 M.W. As the subsequent stages of Sharavati Valley Project will involve only additions of generating and transformer units, demands of industrial power could be met without the least possible delay after the year 1962. The transmission and distribution network will also by then have touched the fringes of the new State, thus making the State of Mysore an industrial power to be reckoned with.

By 1961 the Electricity Board will be committed to an anticipated peak of about 170,680 kW against the available firm generating capacity of 1,66,200 kW thereby making us deficit by 4,480 kW. The load requirements by consumers who have applied for power indicate that a further 222.4 M.W. of power will have to be got ready to cater to the various concerns that will spring up in the State by 1962-63. The completion of the Sharavati Valley Project (first stage) will therefore be an imperative condition if demands of power are to be catered and the State is leaving no stone unturned to try and include this Project in the core of the Second Five Year Plan in order that the industrial prosperity of the State may not be jeopardised.

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*Continued from page* 4

## Atomic Energy Development in India

recent developments have shown the cost of producing power. I am informed that in view of these developments, it is expected that the cost of power from atomic stations would be round about 2.6 nP per unit of electricity, which, I believe, is much lower than the cost of generation of electricity from thermal stations in most parts of India not near the coal fields. If we are to take part in these developments, in future, I think it is necessary to set up at least one atomic power station, to begin with, working on natural uranium. After that we can go on to other processes. It is expected, if we start soon, that *the first atomic power station might go into operation in* 1962.

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# Major Irrigation Projects in Mysore State

By M. V. T. IYENGAR

Prior to 1st October 1953, the State of Mysore had 9 districts with an area of 29,489 sq. miles. After the addition of Bellary district (3,820 sq. miles) the area became 33,309 sq. miles. Now as per the State Re-organisation after 1st November 1956. the area of the New Mysore State is 72,300 sq. miles comprising the 10 district of old Mysore State, part of south Canara District and Kollegal taluk from Madras, Coorg district, North Canara, Dharwar, Bijapur and part of Belgaum District from Bombay, Gulbarga and part of Raichur and Bidar Districts from Hyderabad State.

All the Major Irrigation Works (costing more than Rs 10.00 lakhs) in the following districts of Bangalore, Mysore, Mandya, Hassan, Chickmagalur, Shimoga, Tumkur, Chitaldrug, Kolar, Coorg and S. Kanara come under the jurisdiction of this office.

The Government of Mysore, alive to the needs and development of the State in the field of irrigation and development of power, contemplated the execution of certain Major Irrigation Works the details of which are furnished below. The Major Irrigation Works coming under the jurisdiction of this office can be classified as follows: (1) Projects that are now under execution, (2) Projects included in Second Five Year Plan and about to be taken up for execution, and (3) New Projects that are surveyed and projects prepared. Details are given below.

**Projects under Execution**

The following are the Projects that are now under execution of this Office :—

(i) Bhadra Reservoir project,
(ii) Tunga Anicut project,
(iii) Nugu Reservoir project,
(iv) Ambligola reservoir project, and
(v) Sharavathy Valley Hydro Electric project.

*Bhadra Reservoir Project*

The scheme is to construct a Dam built of rubble masonry in surki mortar across Bhadra River near Lakkavally in Chickmagalur district (latitude) 13°-42′ longitude 75°-33′-20″) 194 ft. high above the average river bed level to store 186 ft. of water. The height of the Dam above the deepest foundation is 235 ft. There are two saddles on left bank, the first is 1,600 ft. long and the second is 780 ft. long; both will be bunded with earthen embankment. The Reservoir will have an effective storage capacity of 63,035 M. Cft. above plus 100 level. Provision has been made for flood discharge over the spillway and through sluices to be built in the river portion of a total quantity of 1,200,000 cusecs of water.

Two channels take off one on either side of the Reservoir. The left bank channel takes off at plus 36 and runs for 50 miles length with a discharging capacity of about 335 cusecs irrigating about 17894 acres of land. The right bank channel takes off at plus 100 with a discharging capacity of 2,500 cusecs. The total proposed atchkat under both the channels is 2,34,200 acres including 10,000 acres in Harapanahalli taluk of Bellary district. It is also proposed to develop 41,040 kW (installed) of electrical power at the Dam site.

The construction work was started in 1947 with the intention of completing it in a period of 10 years. But for want of adequate funds there was a move to close down the works at the end of 1949. Later it was decided to proceed with the project under a 'Go Slow Programme'. This continued till the end of November 1953, At this stage a loan of Rs 3.00 crores has been received from the Central Government for the remaining period of First Five Year Plan with a view to accelerating the progress on this Major Irrigation Project.

The foundation of the Dam is completed and the rubble masonry work has been started and it has come up to plus 122 at left flank and plus 90 at the spillway section upto the end of December, 1957. The excavation of the complete left bank channel has been completed and water was allowed in July 1957 for the full length of 50 miles to serve an area of 16,000 acres of land and the ryots have already started irrigation with much jubilation. The excavation in the right bank channel upto 51st mile is nearing completion. The Tunnel works as well as the Channel work beyond the Tunnel have been taken up, which is going on briskly. It is proposed to complete the entire project by the end of the 2nd Five Year Plan and supply water to the entire atchkat of 2,34,200 acres. Estimate cost of project is 17.75 crores (revised 24.42 crores) and an expenditure during the year 57-58,

upto end of December 1957, is booked to Rs 134.51 lakhs bringing the cumulative expenditure to Rs 987.09. lakhs from the beginning of the project.

*Tunga Anicut Project*

The scheme is to construct a masonry overflow Anicut 1,200 ft. long across Tunga River near Sacrebyle about 7 miles from Shimoga. Provision is made for the discharge of 2,60,000 cusecs of water over the Tunga Anicut upto a maximum height of 13$\frac{3}{4}$ ft. This anicut is of a high co-efficient weir type with an upturned bucket 10 ft. dia. constructod of stone masonry arch work.

Two channels take off one on either side of the Anicut. The left bank channel with a discharging capacity of 550 cusecs runs for a length of 63 miles irrigating about 16,500 acres of land in the taluks of Shimoga and Honnali. The right bank channel with a carrying capacity of 135 cusecs runs for a length of 32 miles irrigating about, 5,000 acres of land in the Shimoga taluk. The total atchkat under both the channels being 21,500 acres.

The work was started in 1946 and the Head Works is completed. The left bank channel has been completed in all respects and water is allowed for irrigation during the irrigation season of 1957 in both the channels to serve the area of 18,000 acres. The estimate cost of the work is Rs. 231.12 lakhs against which to end of December 1957, the outlay is Rs 9.62 lakhs during the year 1957-58, bringing the total outlay to Rs 208·6 lakhs from beginning.

*Nugu Reservoir Project*

This scheme is to construct a Dam 1440 ft. long and 114 ft. high above the average bed level across Nugu river (a tributary to Kabbini river) at Birwal in Heggada-Devanakote taluk of Mysore District, to store 110 ft. of water with a capacity of 4,893 M. Cft. (above the cill of the irrigation sluice at plus 50) to serve an area of 20,000 acres of land in Nanjangud and Heggada-Devanakote taluks. The high level canal from the reservoir takes off at plus 50 on the right flank and runs for a length of 57 miles before it drops into the Norasamedi tank rear Nanjangud.

The work was started in 1947 and the Dam Works is nearing completion. The excavation work in the right bank channel is completed and water was allowed during the irrigation season of 1957 upto full length of the high level canal supplying water to the full atchkat, out of which about 5,940 acres have already come under irrigation.

The estimate cost of the work is 244.25 lakhs and the total outlay to end of December 57, during the year 1957-58 is Rs 13.98 lakhs bringing the cumulative figure from the beginning to Rs. 255.99 lakhs.

*Ambligola Project*

The scheme is to construct a Dam 57 ft. height across Salur Halla near Ambligola village in Shikaripur taluk, Shimoga district, to irrigate 6,894 acres through one channel of 22 miles long. The work was started in 1953 and is in full progress. Preliminary works as surveys, jungle clearing etc., are over. The excavation for the main dam is over and the embankment work has been started. It is proposed to complete the entire work by the end of Second Five Year Plan, and supply water to the entire atchkat of 6,894 acres. The estimate cost of preject is Rs 56 lakhs out of which an expenditure to end of December, 1957—during 57-58—is Rs. 9.62 lakhs, bringing the cumulative figure to Rs 25.68 lakhs.

*Sharavathi Valley Hydro Electric Project*

The Sharavathi Valley Project across river Sharavathi in Sagar taluk of Shimoga district, near Kargal in Jog-Talaguppa road at a cost of Rs 39.45 crores is proposed to be constructed in three stages. This is purely an Hydro-Electric Project. The dam consists of a masonry dam 190 ft. high with an overflow section to impound 1,80,000 M.Cft. utilising all the water for power generation with a continuous draw of 4,500 cusecs. The total length of dam is 7672 ft. The work was started in 1956. Preliminary works such as jungle clearing, formation of roads are completed. The excavation for the main dam is completed and it is proposed to start concreting for the foundation shortly. It is proposed to complete the first stage of work by 1961-62, and generate electric power 1,42,000 kW (installed). The progress during the year 1957-58 to end of 31st December, 1957 is Rs. 60.44 lakhs bringing the cumulative figures 113.84 lakhs from the commencement of the project.

**Projects in the Second Five Year Plan**

The following are the new projects that are included in the Second Five-Year Plan and about to be taken up for execution:—

| *Project* | *Cost* | *Atchkat* |
|---|---|---|
| (1) Kabbini .. | 250.00 lakhs | 31,000 acres |
| (2) Chickholo .. | 26.00 ,, | 3,500 ,, |
| (3) Jambadanalla .. | 44.50 ,, | 6,000 ,, |
| (4) Sagare Doddakere | 14.20 ,, | 1,136 ,, |
| (5) Mangala .. | 13.71 ,, | 1,300 ,, |
| (6) Arkavathy .. | 40.00 ,, | 5,118 ,, |
| (7) Hebbahalla .. | 15.08 ,, | 1,530 ,, |
| (8) Lakshmanathirtha | 30.42 , | 3,167 ,, |
| Total Rs. | 433.91 ,, | 51,801 ,, |

The total cost of all the new projects included in the Second Five Year Plan comes to Rs 433.91 lakhs with a total irrigation benefit of 51,801 acres.

**Projects under Survey**

New projects that are surveyed and projects prepared.

The following two projects in South Canara district are surveyed and and estimates prepared and proposed to be included in III Five Year Plan:

| | *cost* | *acreage* |
|---|---|---|
| (1) Haladi project Rs. | 188.00 | 21,000 acres |
| (2) Byjjur project Rs. | 48.00 | 4,500 ,, |
| Total Rs. | 236.00 | 25,500 acres |

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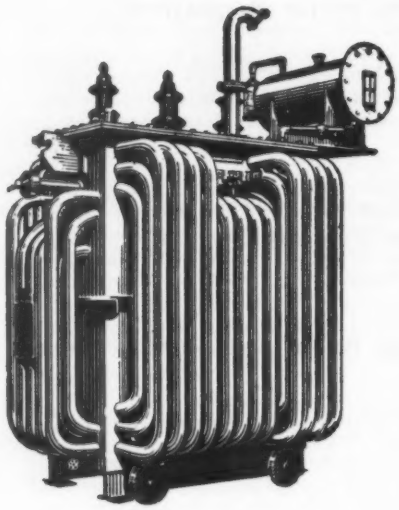

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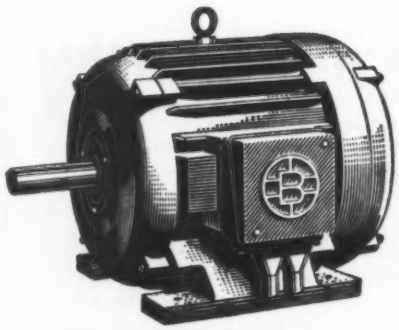

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# Commissioning of Transformer

By R. N. GANGULY

The problems associated with the commissioning of a transformer are diverse and numerous. The main object of commissioning is to prove that the equipment has been properly installed to function correctly. The commissioning of a transformer necessitates a thorough understanding of many practical and theoretical considerations. Although most parts of the equipment may have been workstested, it is not until the gear is installed on site that it is completely erected and put together. Careful preparation, detailed checking of the information available during test, application of appropriate adjustments to any anticipated trouble encountered during commissioning of the transformer will result in successful operation and troublefree maintenance for the future.

The question therefore usually arises as to which of the characteristics are to be checked on site and which are to be taken as correct, particularly in a country like ours where facilities for elaborate and extensive test gears are limited.

On the basis of experience gathered and data collected during the commissioning of several power and distribution transformer in this country a systematic procedure has been laid down in this paper for carrying out commissioning tests with the help of simple instruments and apparatus. The paper also describes the application and functions of modern protective fittings of the transformer and the methods that are to be adopted to check their performances.

### Insulation Resistance Test

Insulation resistance of a transformer may be conveniently measured with a megger. This should be measured with all windings grounded except the one being tested. The following formula gives approximately the minimum satisfactory resistance in meghoms.

$$R = \frac{K.V. \times 30}{\sqrt{\frac{K.V.A.}{\text{Frequency}}}}$$

Where R=insulation resistance at 85°C with windings in air or at 45°C with windings in oil.

K.V.=Kilo volt rating of winding involved.

KVA=Kilo volt ampere per phase of transformer.

The insulation resistance veries inversely with temperature and approximately doubles per each change of 10°C.

### Drying out Test

Drying out must be done properly and carefully to avoid damage to the transformer insulation through over-heating. Drying may be done with the core and coils either immersed in oil or out of oil. When the amount of moisture absorbed is small as in the case of new transformer, the drying out is performed with core and coils under tank. If it is otherwise it is advantageous to dry out with core and coil out of oil as drying could be done quickly by this method. While drying the cover plate is kept open for the escape of moisture. Approximately 50% of the full load current is allowed to pass through the short circuited winding. The oil temperature may be kept down to 85°C by the adjustment of load. Every two hours insulation resistance should be measured. A dielectric test of oil samples should be taken twice daily. If both the oil tests and megger tests continue to indicate dryness for 48 hours the drying out process may be discontinued.

It is wellknown that if the insulation resistance is measured at ordinary temperature it may show high results though the insulation is not fully dried. As the transformer is heated up it will drop rapidly. If a curve of insulation resistance against time is plotted, this will give a clear indication when the insulation has began to increase rapidly. Drying should not be discontinued until insulation resistance is constant at least for 12 hours.

### Ratio Rest

The ratio of transformer could be tested by applying 400 volts on the H.T. side and measuring voltage in different tap position on the L.T. side. These results give a fair indication of operation of tap changing switch and the correctness of turn ratio of transformer.

### Phasing Test

To make a complete test on a 3 phase transformer to verify the phase displacement between the primary and secondary windings the relative phase sequence

of voltage can be conveniently determined by connecting two corresponding phase of H.v. and L.v. and having the transformer emergised with a suitable low voltage on High tension side. A complete set of voltage reading as shown in the chart should be taken between all possible pairs. The common terminal of primary and secondary fixes the vector diagram from which correct vec. group reference could be found out.

| | *VOLTS* : | | |
|---|---|---|---|
| Connect any two corresponding phase of H.V. and L.V. | R-r=0 | R-y =106 | R-b 106 |
| | T-r=430 | Y-y =345 | Y-b =445 |
| | B-r=430 | B-y=342 | B-b=342 |

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**Tap Change Test**

If the transformer is provided with an onload tap changer following points should be checked :

(*a*) *Manual Operation*
By hand over complete range O.K.
Visual check on limit switch operation O.K.
Tap change motor & cables insulation test 20 M.ohms.
Meggered at 500 volts
Tap change motor starting current 10 amps.
Overload coil setting 5
Tap change in progress alarm O.K.
Limit switch 'raise' O.K. 'Lower' O.K.
Breake alignment etc. O.K.
Fimger tension and alignment on Drum Controller Normal.

(*b*) *Remote Operation* O.K.
(*c*) *Parallel Operation and* Out of step alarm O.K.
(*d*) *Tap change continuity Test* O.K.

(*i*) H.T. short circuited and current measured at L.T. with 400 V supply ; tap changer is operated normally over complete range and the ammeter is observed through out to make sure that the current is not interrupted. .....

(*ii*) Measure current and voltage at normal tap.

| *Amps.* | *Volts* | *Impedence* |
|---|---|---|
| | | |

(*e*) *Time of one complete* Operation of tap changing by remote control 20 Sec.
(*f*) *Megger Test on control and Indicator circuit* 20 M.ohms.

**Oil Test**

Good quality transformer oil is essential for satisfactory operation. If the transformer requires refilling during commissioning the condition of new oil should be carefully recorded and checked.

The only pure electrical test given in BS148/1957 consists of subjecting the oil sample to a voltage of 40 K.V. for one minute after rising from 15 K.V. in fifteen seconds across a 4 mm. gap between two 12 mm. spheres. After withstanding the B.S. test a further voltage is generally applied until the oil actually breaks. This should be noted and the ambient temperature recorded.

Presence of moisture may be checked by a simple test. A 5" long test tube with about one quarter filled with oil is heated gently in a silent flame until the oil boils. During the process no crackle should be detectable.

Filters remove solids easily but it is difficult to remove small quantities of water. Oil may be filtered by two methods :—
(1) dealing with hot oil. (2) dealing with cold oil.

In hot filtration the contaminated oil enters the plant where it is heated and passed over filter paper pad into a vacuom receiver for intense drying and deaerating action and thereby solid impurities or colloidal carbon, dissolved water and dissolved gases are eliminated.

With cold filtration method the oil is treated with activated earth and the water eliminator extracts any water before finally it is passed through the filter bed to the clean oil tank. There is no heating and no moisture in solution, no oxidation. Extremely fine suspended impurities and colloidally dispersed carbon can be removed by this process.

The first method is suitable during drying out process of transformer during commissioning while the second method is very economical for filtering contaminated oil from drum or oil of transformer in service.

**Protection of Trasformers:**

1. A general survey of the whole equipment.
2. Diagrams are to be checked and whenever necessary simplified diagrams for future reference are to be drawn.
3. To test C.T. ratio by primary injection and measuring the secondary current and to test polarity with a low voltage battery and a polarised voltmeter by applying make and break method.
4. All wiring connections are to be checked against diagrams. Visual check for loose connections—and generally inspect the equipment.
5. The insulation resistance of all wiring is to be meggered before earthing the secondary circuit.
6. Special tests are to be carried out to prove that it has satisfactory stability on external faults and adequate sesitivity on internal faults.
7. Tripping and inter-tripping tests with careful observations of the indicator's flag operation and alarm.

*Winding Faults.* Fig. 1 & 2 show the connection of C. T. secondaries in the incoming side of the Transformer to an Earth Fault Relay arranged for instantaneous

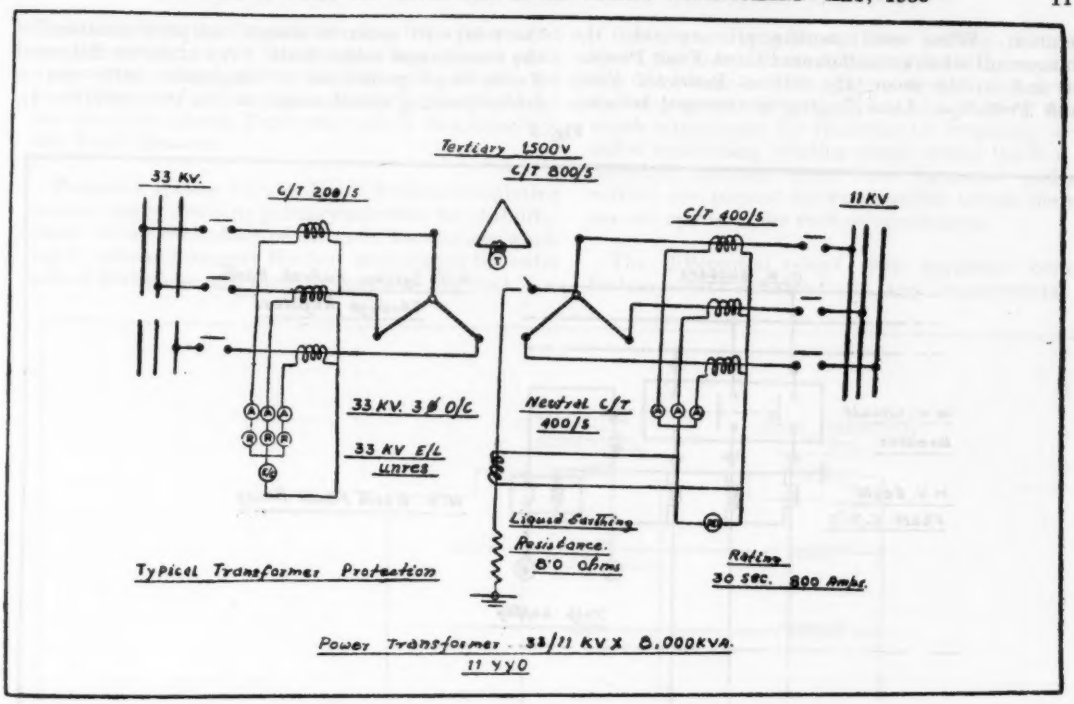

Tertiary 1500V
C/T 800/5
33 KV.
C/T 200/5
C/T 400/5
11 KV
33 KV. 3 ø O/C
33 KV E/L
Lines
Neutral C/T
400/5
Liquid Earthing
Resistance.
8·0 ohms
Rating
30 sec. 800 Amps.
Typical Transformer Protection
Power Transformer 33/11 KV X 8,000KVA.
11 YyO

Fig. 1

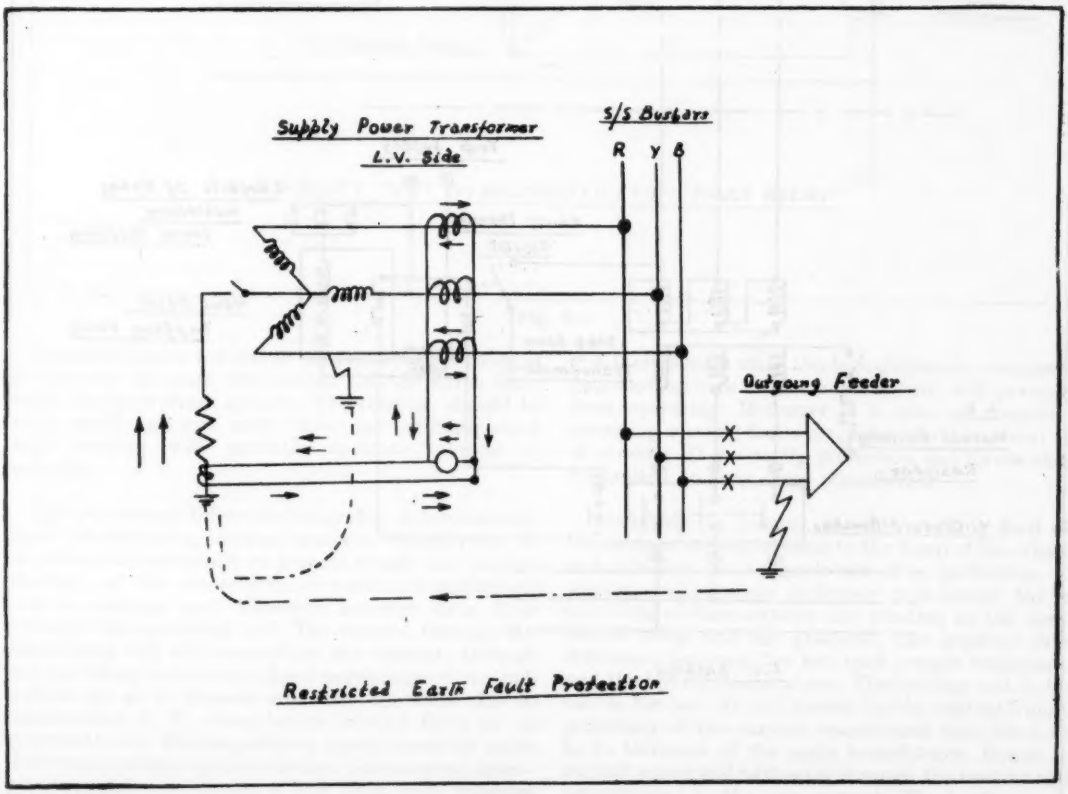
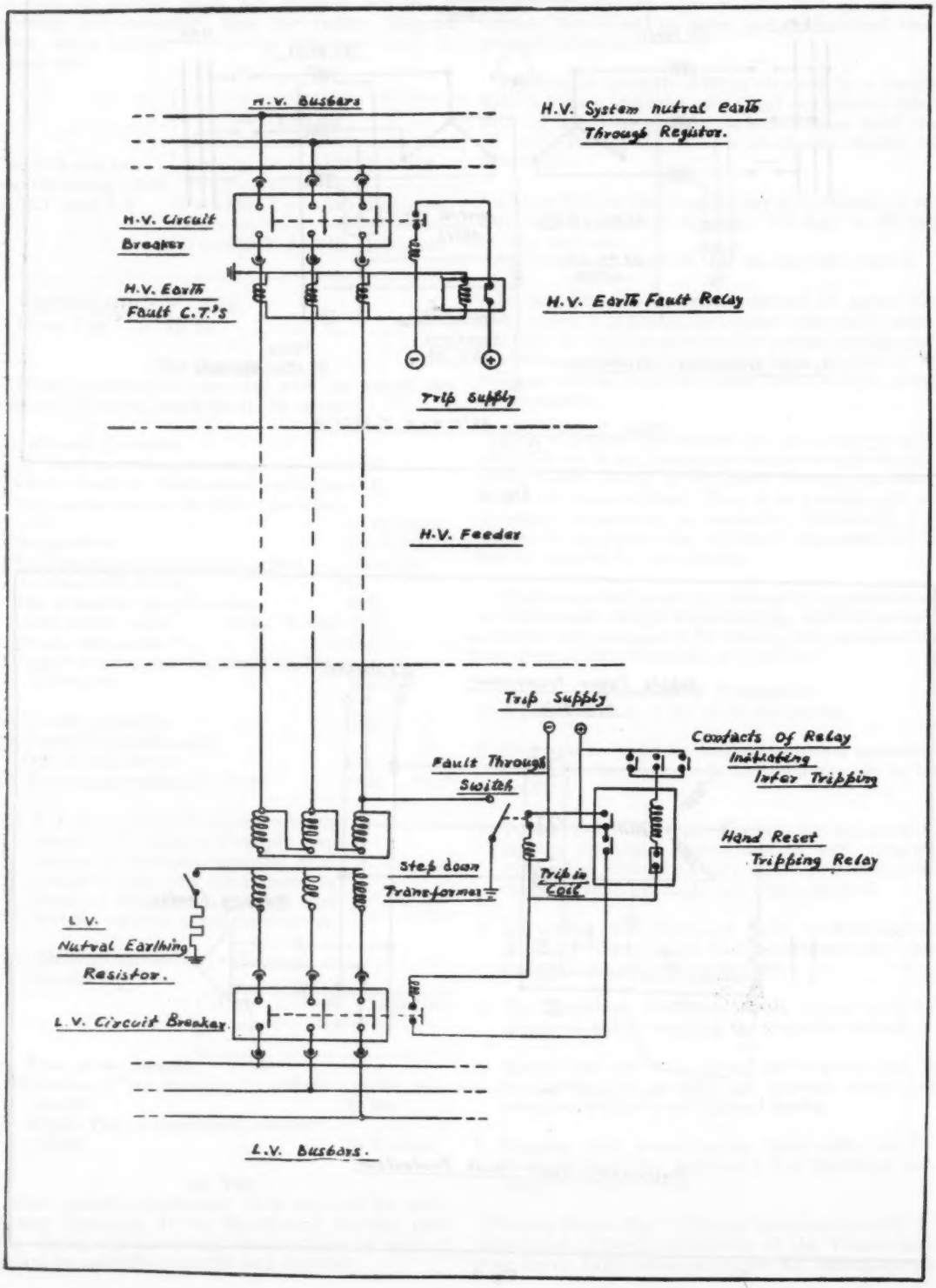

Supply Power Transformer
L.V. Side
S/S Busbars
R
y
B
Outgoing Feeder
Restricted Earth Fault Protection

Fig. 2

operation. When used on the primary side the arrangement is known as *Balanced Earth Fault Protrection* and on the secondary side as *Restricted Earth Fault Protection*. Intertripping is arranged between the relays in order to assure complete isolation of the transformer under fault. Very often the Balanced Earth Fault protection is dispensed with and a fault-throwing switch connected in its stead (Fig. 3).

**Fig. 3**



Then a fault on the Primary winding trips its nearest supply switch, whilst directional relays or even plain overcurrent relays on the fed side will isolate the secondary. A fault in the secondary winding trips the Restricted Earth Fault relay which then intertrips the Fault Thrower.

Balanced system such as Earth Fault or circulating current can be tested by primary injection for stability. Short circuit each phase of the main transformer winding in turn and connect the test set between the outer end of that phase and earth as shown in Fig 3(a).

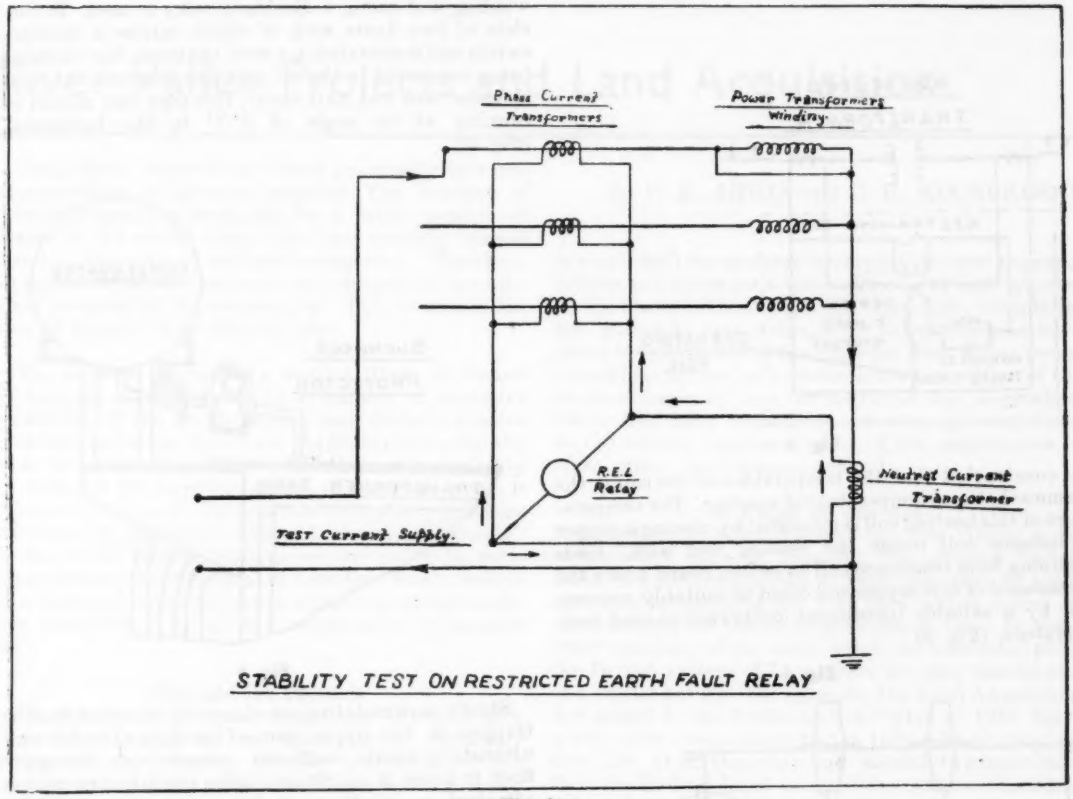


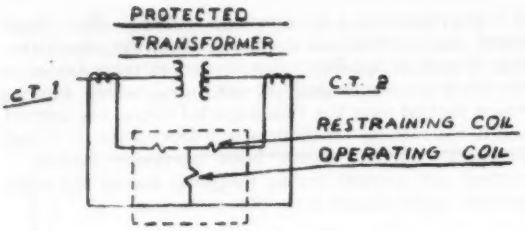

**Fig. 3**(a)

Inject as large a current as the test set is capable of giving and measure the current in the earth fault relay for each phase in turn. The reading should be very small and not more than one milliampue. A high reading will probably indicate reversal of polarity.

The percentage differential relay (Fig. 4) is commonly used for detecting internal faults in transformers. If an internal shortcircuit or ground occurs, the current flowing in the secondaries of current transformers will be unequal and difference between them flows through the operating coil. The current through the restraining coil will necessitate the current through the operating coil to be a fixed percentage of through current so as to prevent any false operation due to mismatched C. T. when heavy current flows to an external fault. The magnitizing inrush tends to make differential relays operate falsely. A slow speed induction type differential relay is free from such troubles if it is given a long enough time setting. For High Speed relays which are necessary from the consideration of system stability a Harmonic restraint devise in the relay is incorporated. It has an operating winding which carried only the fundamental frequency current and a restraining winding which carries the d. c. and harmonic current. Since both harmonic and d. c. current are present during magnetic inrush the relay oes not operte under such circumstances.

The differential relays with harmonic restraint feature is very suitable for in large transformers. But if a fault occurs when the transformer is energised it may not operate as harmonic inrush will prevent it from operating. Moreover it is also not capable of detecting winding faults involving less than about 10% of winding. It is a costly protection and its use should be limited to very large transformer.

*Overeating.* In general, the safe working load of a transformer is proportional to the temp of the winding and this fact can be made use of in protection. The winding temperature indicator reproduces the hot spot temperature outside the winding as the sum of hot-oil temp and the gradient. The gradient is the difference between the hot spot copper temperature and the hot oil temperature. The heating coil is located in the hot oil and heated by the current from the secondary of the current transformer associated with L. V. terminal of the main transformer. Hence the current which will be flowing through the heating coil is proportional to the line current. The heating coil is



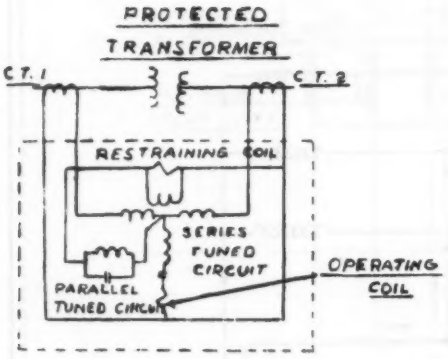
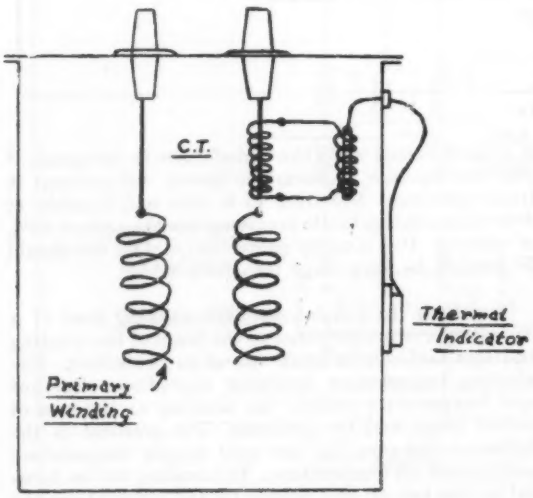




Fig 4

so constructed that the temperature of the coil is the same as hot spot temperature of winding. The temperature of this heating coil is measured by placing a copper resistance coil inside the heating coil with leads running from resistance coil to switch board where the resistance of this copper coil could be suitably measured by a suitable instrument celibrated to read temperature. (Fig. 5)

Fig. 5




THERMAL PROTECTION

Movement of the indicator pointer is arranged to operate an alarm circuit when the temperature reaches 80° C and to trip and so isolate the transformer when the temperature reaches 90° C.

By secondary injection through the heater coil the performance of the winding temperature indicator could be determined. The operation of winding temperature indicator to close the trip circuit should be checked.

*Arcing Faults.* To protect against arcing faults which might occur between turns of winding or between a winding and earth, a Buchholz relay is used. It consists of two floats each of which carries a mercury switch and is mounted in a steel chamber, the chamber being connected in the oil pipe line between the conservator tank and Main tank. This pipe line should be running at an angle of 3°-7° to the horizontal. (Fig. 6).

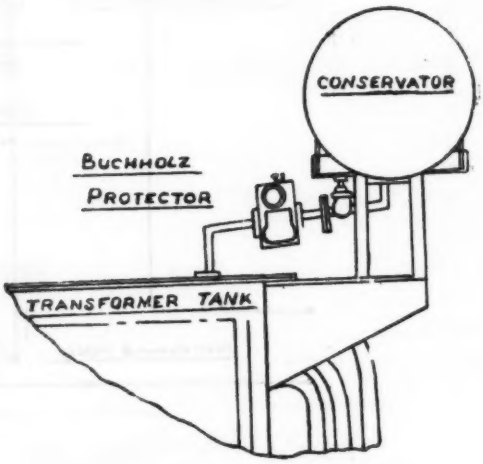



Fig. 6

Slowly accumulating gas caused by incipient fault is trapped in the upper part of the main chamber and ultimately exerts sufficient pressure on the upper float to cause it to tilt and close the mercury switch attached to it. This condition does not call for immediate dsiconnection of the transformer so it is arranged to annunciate a buchholz alarm. Analyses of gas generally gives 60-80% of $H_2$, 10-20% $CH_2$ and some $CH_4$. There will be little air since quantity of gas produced is large.

The lower float attached to a flap is actuated only by a rush of oil which is generally associated with a major internal fault, so the lower float contacts operate a master tripping relay which in turn opens both H.v. and L. v. switches, hence completely isolates the affected transformer. (Fig. 7).

*To test the upper float* a small amount of air is injected in the relay and it may be seen whether the alarm contacts operated properly. A typical relay may be adjusted to operate with 15 cubic inches of gas. It is theoretically possible for 15 cubic inches of gas to be released from the oil without the occurence of fault. Oil at 25°C can dissolve about 10% of its volume of air and at 15°C 11.2%. Hence sudden cooling may liberate sufficient gas to give alarm. Thus

[ *Continued on page* 33

# River Valley Projects and Land Acquisition

By P. R. AHUJA and C. K. KOCHUKOSHY

Compulsory acquisition of land apparently involves expropriation of private property. The sanctity of private property is recognized by a large number of States in the world today. But this sanctity cannot stand in the way of national prosperity. Therefore, all rights to private property are subject to the ultimate interests of the community. This is true in the case of River Valley Projects also.

The modern concept of a welfare State is bound to impinge adversely on all principles of exclusive ownership. If the people expect their State to achieve economic and social objectives, the State must naturally have the necessary machinery and the manoeuerability to work for the implementation of the goals which it is expected to reach. The power of compulsory purchase possessed by the State is termed "eminent domain" in the United States. Such powers are not to be questioned because the functions of a modern State consists of a series of unprecendented duties and responsibilities complicated by all the complexities of modern life.

### Plan and the Projects

It requires to be made clear that River Valley Projects of our Five Year Plans do not form any absolutely novel feature of the activities of the Government of India. They have been existing in this country since centuries ago. Even during the British period there were quite a number of water utilisation schemes in this country. By the time the British gave up their hegemony, India had already assumed a supreme place in the field of irrigation throughout the world. What actually happened on the eve of the First Five Year Plan was that a few projects which were already in advanced stages of planning or construction were dovetailed into the scheme of the Plan. One might ask in this context as to what then is the significance of the huge river valley schemes which the Government of India undertook since the advent of freedom. The answer is that the concept of an integrated development of the basins of our mighty rivers and the recognition of the supreme role the State has to play in their development are indeed an entirely new feature of a new country throbbing with vitality and the spirit of regeneration. Never had we such an adventure of constructon on a mammoth scale as we have today. It is in this context that we have to examine the application of the land acquisition act to the problems of river valley development. To put it in a nut-shell the problem is simply this: new responsibilities and duties for social welfare have been imposed on the State; without regard to inter-state boundaries and parochial approaches river valley schemes have got to be implemented; the State has been given power to mobilise the nation's resources for the welfare of the whole community; how far the law of land acquisition which had been formulated decades ago contribute to the smooth implementation of the programmes of river valley development today ?

### A Focus on the Act

Even before 1870 the acquisition law existed in its rudimentary form in England. The present Indian Land Acquisition Act took its form more than 60 years ago. It was passed as Act I of 1894 and is based on the principles of the English Common Law. In some other countries of the world which are associated with the British system of Law, there are also enactments of a similar nature. For example, the Land Acquisition Act passed by the Parliament of Ceylon in 1950 bears a very close resemblance to the Indian Land Acquisition Act. It is, therefore, not possible to argue either that the Indian Land Acquisition Act is somewhat unique or that our Land Acquisition regulations are completely obsolete. We only propose to examine the application of this Act to the massive requirements of today when the State has to execute a large number of mammoth River Valley Projects.

### Public Purpose

First of all let us examine how the present land acquisition act actually operates. It is based on the principle that for a "public purpose" land can be acquired by the State. The definition of a "public purpose" is not given in the Act but its meaning is rather wide. Even the requirements of a Company registered under the Indian Companies' Act or a few other similar enactments come under the category of a public purpose The Constitution of India (Article 31) provides for the payment of compensation when property is acquired for a public purpose. The fourth amendment of the Constitution, however, leaves it to the legislature to decide the quantum of compensation to be paid when property is to be acquired. This quantum is not questionable in any court of law. The land acquisition act

on the other hand provides that land acquired under the Act should be paid compensation on the basis of the market value of the land and a few other relevant factors detailed later in this article. The expression "public purpose" according to Sub Section (f) of Section 3 of the Act, includes "the provision of village sites in districts in which the appropriate Government shall have declared by notification in the official Gazette that it is customary for the Government to make such provision". In its application to the Uttar Pradesh State, the land acquistion act, except for the purposes of the Union, has been amended to include

1. sanitary improvements of any kind including reclamation

2. the laying out of village sites, townships for the extension, planned development or improvement of existing village sites for townships and

3. the settlement of land for agriculture with the weaker section of the people.

The scope of "public purpose" as exemplified in very many judgements of the various High Courts is indeed a very wide one. The land required for the extension of a Maternity Home and Child Welfare Centre, for Military purposes, for building a Public Library etc., have all been declared to be fit purposes under the general category of a public purpose. The only pre-requisite to the actual acquisition is a notification to be issued to the effect that land in a particular locality is needed or is likely to be needed for any public purpose and the Collector is authorized to issue this notification in the official gazette. Once this notification is issued, it shall be lawful for any officer to enter such land for survey or other acts necessary for the acquisition. Section 5 provides that damage is payable to the owners if caused by the officers in the discharge of such duties. It is also provided by Section 5 that objections may be raised by the parties concerned before the Collector. The objections will be duly considered and a declaration of intended acquisition is to be made by the Government. Subsequently the land is marked out, measured and planned. The Collector has to display public notices at convenient places "on or near the land to be taken" stating the Government's intention and calling for claims of compensation. According to Sub Section 2 of Section 9 "Such notice shall state the particulars of the land so needed, and shall require all persons interested in the land to appear personally or by agent before the Collector at a time and place therein mentioned (such time not being earlier than fifteen days after the date of publication of the notice), and to state the nature of their respective interests in the land and the amount and particulars of their claims to compensation for such interests, and their objections (if any) to the measurement made under Section 8. The Collector may in any case require such statement to be made in writing and signed by the party or his agent".

### Acquisition Proper

The Collector is to give his award on the day fixed by him and in it he has to make a statement of the true area of the land, the amount of compensation and the persons believed to be interested in the land. The award given by the Collector is to be final unless it is challenged by any interested party who can ask for a reference of the case to the Court. Such an application has to be made within a specific time limit. The Court will hold the relevant proceedings in open and after considering relevant factors determine the amount of compensation to the awarded. This decision of the Court will be final for all practical purposes. There is also provision in Part VI of the Land Acquisition Act for temporary occupation and use of any waste or arable land for a period not exceeding 3 years.

It is necessary to indicate the main principles which are to be taken into consideration for determining the amount of compensation.

1. The market value of the land at the date publication of the Notification.

2. The damage sustained by the persons interested by reason of the taking of any standing crops or trees.

3. The damage sustained by the person interested by teason of severing such lands from his other lands.

4. The damage if any sustained at the time by reason of the acquisition injuriously affecting his other property movable or immovable in any other manner or his earnings.

5. If the person is compelled to change his residence in consequence of acquisition, the reasonable expense, if any incidental to such a change.

6. The damage bonafide resulting from diminution of the profits of the lands between the time of the publication of the declaraction and the Collector's taking possession of the land.

7. In addition to the market value of the land, the Court is enjoined to award in every case a sum of 15 per cent on such market value in consideration of the compulsory nature of acquisition.

The Act has also enumerated 7 other factors which are not to be considered by the Court in determining the compensation. These are the degree of urgency which has led to the acquisition, disinclination of the person to part with the land etc.

### Difficulties

It is clear from the above that the entire land acqisition act is framed and visualized for the acquisition of limited estates and properties. The dislocation and the inconvenience visualized in the process of acquisition are purely of a marginal nature. It is also clear that the procedure outlined above is basically a modus-operandi for the payment of compensation for land acquired. No factor other than land finds any emphasis in the entire vista of this enactment. It is, of course, not possible to argue that the Land Acquisition Act is either an incomplete or an insufficient instrument for the day today requirements or the nation. But its rigid application has lead to certain difficulties which are all the more poignant in the context of the modern welfare state.

### Landless People

Take for instance the case of the innumerable landless people who are affected in almost all cases of

acquisition for River Valley Projects. People who lose their land partly or fully get compensation on the basis of the acquisition act even when large number of villages are uprooted. But we cannot argue that relief should be confined exclusively to the landed gentry. With adult franchise in the political field, equality in the economic field becomes all the more necessary. The usual practice is to offer to these landless people some rehabilitation facilities and try to keep them contented here and there. But they do not have any recognized right to demand any rehabilitation or press forth their claims for special consideration when they are uprooted along with their landed neighbours. It is not only the landless labourers who suffer but also the petty businessmen and other domestic workers who are involved. A small village shopkeeper for example loses his entire clientele when the village, *en mass*, moves out dislocated and dis-organized. So does a tailor or a barber. These are people for whom the modern welfare state has a definite respensibility.

### Acquisition Levels

Another difficulty in acquiring land for River Valley Projects is the lack of absolute certainly about the levels of acquisition. While it is possible to decide a particular level after taking into consideration the effects of back flow, wave wash etc., the real demarcation of this level in the villages partly affected by the reservoirs is not alltogether an easy proposition. Experience has been that complaints are made by the people affected as to the adverse effect of a particular storm or flood during some monsoons.

### Flood Frequency: U. S. Practice

At this juncture it is necessary to introduce the idea of flood frequency. If a flood of a particular intensity is expected only once in 10 years, it is designated as a 10 years flood, if only once in 50 years it is a 50 years flood. Obviously the frequency of these floods are to be determined by statistical methods of probability. If a flood is probable only once in 10,000 years, it is obvious that it would be highly uneconomic to make provisions in the designing of a dam to take care of such an unusual flood. Therefore, the requisition of land up to such a high level would be unwarranted. The amount of land to be acquired for a reservoir, of course, depends upon the frequency of the flood expected, the use of the reservoir and design of the dam. The practice in the United States is that for controlled spillway land is acquired 2 to 5 ft. above the elevation of the top of gates which increases upstream from the dam, based on back water effects of passing the reservoir design flood. For uncontrolled spillways the policy is not fixed.

### Flowage Easement

In some cases where there is periodical flooding and land owners are interested in retaining control of their land, flowage easement is paid by the State. The Government makes the appropriate payment to the land owners to cover all future damage which might occur due to flooding and the land owner retains the ownership and control of the land. Thereafter the land owners cannot claim damages for any frequency of flood.

There is bound to be differences of opinion regarding the particular flood frequency to be adopted for land acquisition. No uniform basis seems to have been evolved as yet for the determination of this level. And a difference in the level would mean sometimes a considerable difference in the cost of the Project and also the convenience of the people affected. The Land Acquisition Act of India being primarily meant for purposes other than River Valley Projects has not visualized any of these difficulties. There is also no provision equivalent to the purchase of the right of flowage easement in our law. One big advantage of the purchase of flowage easement is that while damages may not be claimed any more, the land will remain on the tax roles of the State. If the value of the land increases due to any reason, the State can expect increased returns through the taxes. It may incidentally be pointed out that land below the normal acquisition level might itself be available for seasonal cultivation during a good part of the year as the reservoir level goes down. It would indeed be a good idea if the allotment of such land for seasonal cultivation be considered in favour of landless agriculture labour who might be dislocated as a result of acquisition.

### Landowners partially affected

Yet another difficulty which is faced during land acquisition is the question of people whose lands are affected by acquisition but whose homesteads are intact and situated at comparatively elevated levels. Authorities who have something to do with land acquisition might bear witness to the fact that in many projects the number of such partially affected people is not extremely small. It is a practice amongst villagers to build their houses at comparatively higher levels and have their agricultural farm lands at lower levels around. Very often it so happens that most of their land might be acquired for the purposes of the reservoir and they might be left with just their homesteads. This eventuality need not necessarily come under the Fifth Category of principles enumerated above which are to be taken into consideration for determining the amount of compensation. This is so because one can always argue that so long as the homesteads are intact a person is not compelled to change his residence. In such cases a sympathetic consideration is always called for. It would appear to be a sound principle that even when homesteads are not in danger of submergence if an individual is left with an uneconomic holding as a result of the acquisition of the rest of his property he should be helped to move out. This would be possible if his homestead is purchased by the Project Authorities and some shifting charges paid to him. The justification for this consideration is that the person concerned has been put to this particular predicament on account of the acquisition of his land for a public purpose.

### Isolation of Villages

In the case of acquisition for River Valley Projects on a mass scale, it is also possible to visualize that anamolous situations could be created because acquisition is to be based on a particular level arrived at as a result of techanical requirements. There may be for example a village above the level of acquisition but surrounded by contiguous villages which are all below the particular level. When the reservoir reaches its level, the villagers might find that they are surrounded on all sides by water and the village life might be completely jeopardised. In a less aggravated form there may be villages which are surrounded on three sides by water with just a nominal land connection with the rest of the area. The entire transport and communication system of the villages might by paralysed. Perhaps

the side through which it is connected to the main land may be inaccessible or completely wild and undeveloped. Here again there is no provision in the land acquisition act which could be invoked by the villagers concerned for demanding better communication with the rest of the country. It is not proposed to argue here that such problems are acutely insurmountable. What is being done in such cases is to provide alternative roads connecting villages thus affected and alleviating the difficulties of the people. But such considerations and activities come within the welfare sphere of the Government and not at all within the jurisdiction of the acquisition law.

It is, therefore, clear that on the whole the present land acquisition act is intended for the protection of the interests of individual land owners, whereas the problem of land acquisition vis-a-vis our big river valley projects is one of safeguarding the collective interest of a community. Here is the basic conceptual difference.

### Inter-State problems

It would not be proper to conclude this article without referring to a special difficulty which land acquisition for interstate projects especially entail. There are projects in this country whose headworks or main dams fall within one state but whose benefits accrue to a different state. There may be projects in the construction of which more than two states might be interested. In any case interstate differences of opinion sometimes tend to be acute in the case of some projects. Land might be acquired from one state and its payment will have to be made by the Government of another State which is interested in the construction of the project. There might be allegation that in such cases land acquisition might be extraordinarily costly. The implication is that because land is to be acquired by the Revenue Department of a State in which the project is situated, the local revenue authorities might propose compensation on a higher scale which they would not have done if their own Government had to foot the bill. Also it might be alleged that more land than what is absolutely necessary has been recommended for acquisition purposely to benefit the people in the locality. There may also be differences of opinion regarding the level of acquisition and other criteria leading to the determination of this level as well as for the assessment of the market rate stipulated as per Section 23 of the Land Acquisition Act. There may be heavy claims under the doctrine of "Injurious Affection" and "Severance". An interestate problem of this nature has not been visualized in the Land Acquisition Act. The consequence is that acquisition is not carried out and protracted negotiations continue between the States thus putting the people to great embarrassment, dissatisfaction and even to loss. It may be pointed out that in such cases, the Central Government might step in as provided in the Constitution. But invoking the relevant article of the Constitution for such petty differences between States is not at all desirable nor is it an easy proposition.

All this is not to suggest that there is an inevitable necessity for the amendment or modification of the present Land Acquisition Act. In may be quite possible to carry on as we have done so far. But our intention is only to draw the attention of all those concerned to these difficulties which accompany land acquisition for river valley projects.

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## Submarine Power Cable for New Zealand

In March, 1956, the BICC Group were instructed to investigate the practicability of linking the rich electric power resources of New Zealand's South Island with the supply network of the industrial North Island. This investigation resulted in an announcement on April 28th, 1958, by Mr. H. Watt, the Minister in charge of the New Zealand State Hydro Electric Department, that the BICC Group are to lay, test and recover a trial length of cable in order to provide data for the ultimate installation of a submarine power cable across Cook Strait.

The trial cable, half a mile in length and with an overall diameter of 5 inches, was manufactured at the Trafford Park Works of British Insulated Callender's (Submarine Cables) Limited; it is of the single-core pre-impregnated high-pressure gas-filled type, and is to operate at 250,000 volts D. C. It has a hollow copper conductor, is paper-insulated and lead-sheathed, and is suitably reinforced with steel tapes and steel wire armouring to withstand the particular conditions of the sea bed under Cook Strait.

This trial cable was not of sufficient length to warrant transport by a cable-ship as would be the case for the continuous length required for the complete crossing. The cable was coiled on a giant drum believed to be the largest ever produced. This drum was 15 feet 8 inches in diameter and 7 feet 6 inches across, and, with the cable, weighed about 45 tons. It left Trafford Park Works on 24th February, was loaded aboard the s. s. "Carronpark" at Liverpool, and arrived in Wellington, New Zealand, on 16th April.

Under the supervision of engineers from British Insulated Callender's Construction Company Limited, the trial length will be laid by the New Zealand Post and Telegraph Department's cable-ship HMTS "Matai" seawards from Oteranga Bay, which is on the North Island shore of Cook Strait south of Cape Terawhiti. After the ends have been sealed, the cable will be anchored and allowed to remain on the sea bed for as long as possible.

For the full length cable the projected Cook Strait crossing route is a distance of some 25 miles, with a maximum depth of 150 fathoms.

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# Drainage Study of Lower Damodar Valley—VI

**Probable Effects of D.V.C. Dam Regulation on the Lower Reach of Damodar**

By SATYAKAM SEN

Before attempting to assess the possible effects of D.V.C. Dam Regulation it is essential to study past and present river conditions prevailing in the Lower Reach of Damodar, as ascertained from previous observations.

## Present and Past River Condition in Lower Reach of Damodar—A Summary

### Present Conditions

The present hydrological condition of the Lower Reach of Damodar has been carried out with respect to the factors of rainfall, evaporation, runoff, siltation, tides and groundwater table.

The findings from the present investigations in respect of these various factors are summarised below:—

*Rainfall Characteristics*

Earlier workers have recorded that so far as the Damodar Catchment area is concerned, rainfall is hardly excessive. Even considering the monsoon months, the observed difference from normal rainfall is negligible.

The present study also shows that even if storm tracks pass by, or run over, the catchment area, this also experiences heavier rainfall than some of the neighbouring areas. However, apart from this question of intensity, the frequency of rainfall undoubtedly rises considerably during the monsoon period, although both the intensity and the frequency of rainfall in the Damodar Valley seem to show selective as well as directional trends in the matter of incidence of precipitation. These trends naturally occur in conformity with the wind system, the relief, land-form etc. Consistently with these rainfall characteristics, it has been noted that the discharge of the Damodar River rises at Rhondia with the incidence of the monsoon rains.

*Evaporation*

Evaporation at Alipore meteorological centre, Calcutta which is very close to the Bay of Bengal, is largely under the influence of moisture-laden wind from the Bay. But in the other, particularly the upper catchment, stations, evaporation seems to be dependent on the altitude which of course acts through rainfall and temperature, and also on the soil texture.

Importance of rainfall and temperature in modifying the evaporation rate is clearly indicated by the results obtained from the present investigation. It is found that evaporation is greater before and after the monsoon period, the atmosphere then experiencing a saturation-deficit in water vapour for lack of rainfall. In fact, in the summer month of April when temperature is very high and, at the same time, rainfall is insignificant, evaporation assumes the maximum rate. Thus we find that the evaporation loss is low in the Lower Reach of Damodar.

*Run-off Characteristics*

The behaviour of the Damodar river system is like that of most other monsoon-fed river systems of India. While about 90 per cent discharge occurs between June and October, during the other months, the rivers are practically dry.

It is to be noted that a study of the drainage system of the Trans-Damodar area does not however provide a full account of the discharge-deficit that occurs between Rhondia and Mohiddipur. What this fact obviously suggests therefore is that the difference of discharge, such as appears to be unaccounted for, may probably be due to water spilled over the Trans-Damodar area. It is important to remember in this connection that the Trans-Damodar area is situated on the rightbank side of the river, where there is no embankment, making spill in the bank-full stage of Damodar, during flood, quite highly probable. Historical record also shows that this area has actually gained 5 to 10 ft. in elevation within the last 82 years. This is most likely to be due to silting, for when the river in flood has overflown its right bank and spread over the plain, it must have lost speed favouring sediment deposition. Thus historical fact sustains the spill-hypothesis. This observation is also consistent with the topography of the Trans-Damodar area. Such feature as the gutter-shaped surface of Burdwan, for example, indicates that the flood water once entering the area under high flood condition, finds it difficult to return to the river when the flood has subsided and the river level has fallen.

Besides this, there is another feature of the Damodar runoff in the Lower Reach. The river Kaki is fed by a major portion of the water taken off from the Damodar discharge by Muchi and Begua-hanas; this

happens both in flood and during the dry season. As a result, the Lower Reach of the main Damodar river has become constricted.

*Suspended Load*

Damodar carries its load of fine suspended matter to the Lower Valley, after the coarser bodies have dropped off earlier in course of its process from the upper catchment basin, particularly from the Chhotanagpur Plateau where gully erosion is extensive. The erosive activity in here is mainly accentuated by human action such as, deforestation, over-gazing, forest firing mining and unscientific cultivation. The eroded matter from this area, as suspended fine particles, are carried over profusely to the Lower Valley by the augmented monsoon flow of Damodar.

It was found that during monsoon, an appreciable silt charge occurs at Mohiddipur (Kaki), as the Kaki river carries away most of the Damodar flood water. The silt charge at Mohiddipur (Damodar) is correspondingly insignificant. It was also found that the suspended load happens to be somewhat greater in Mundeswari than in Harinakhal (at Rautara) and Kabla Nadi (at Mayapur), two drainage channels.

Of course during the pre- and the post-monsoon months, the river channel is practicly dry, and the surface current, even as it reaches the lower valley, is remarkably feeble.

*Tidal Charactristics.*

A study of the tidal incidence was made in six stations of the Lower Reach, viz., Amta, Khararghai, Gaighata, Baxi, Baligori and Bansbera. Some of these stations lay on the outfall channels of Damodar, and others on the Lower Damodar itself. Observations made at stations on the Damodar bifurcation below Mohiddipur were also needed for comparison.

It is observed that at Amta and Bansberia, the high and low water levels exhibit fluctuating peaks with the appearance of the full and the new moons. These peaks occur very clearly in the pre- and post-monsoon months. Further, whereas in Amta the monsoon discharges wash away the distinctive features visible for the rest of the year, in Bansberia, the effect of monsoon is less prominent.

In Khararghai, on the other hand, where also fluctuations occur but irregularly, of course doing so through out the year, the effect of upland discharge is apparently small. While, in the two former stations, the tidal conditions attendant on the two limiting lunar phases, seem to be the most effective, in Khararghai probably even the daily tides make their presence felt, and thus produce apparently irregular fluctuations.

In Baxi and Gaighata, the fluctuations in the water levels are prominently indicative of tidal influence during the monsoon months, that is when upland discharge is high.

These observations therefore leave no doubt that the estuarine Lower Reach of Damodar is under the influence of tides, more significantly at some places than in others, and more generally during the monsoon periods. Comparing the observed conditions in the stations of the tidal reach with those recorded below Mohiddipur bifurcation, it becomes clear that when the upland discharge is low in the lower Damodar channel below Mohiddipur, the tidal limit gradually extends inwards. But when the upland discharge through this channel is considerable a portion of its flood water reaches Amta, and sometimes goes upto Gaighata. On occasions of high upland discharge, the flood water even reaches upto Bansberia.

Again, it seems that the effect of local rainfall is not quite apparent in the water level fluctuation at Amta and Gaighata, although some effect, but not much, is indicated by the observations made at Baligori.

The low, and somewhat undulating, topography, and the drainage system prevalent in the tidal reach have caused the occurrence of marshy lands. These marshes and the drainage lines have brought about the feebleness of the channels. While, therefore, during the pre- and post-monsoon periods, the tides dominate, during the monsoon floods, the upland discharge supervenes the tides. As the upland discharge has now lost in power following construction of dams in the upper reach, it is likely that the tides, with all their complements of silt and salinity, will continue to push on upwards.

*Fluctuation in Ground Water Table*

In the Lower Reach of Damodar the ground water tables have been studied, particluarly with respect to their waterlogging possibilities or otherwise. Although for the early years (1933-49) only well-measurement records of selected spots are available, for 1955 proper piezometer readings from thirty units have been obtained. While the earlier observations therefore provide only a broad over-all view of the nature and short-period fluctuations, the more extensive piezometer data are amenable to better study.

From the well measurements it is gathered that in the Northern portion of the Howrah district lying between the Damodar and Hooghly rivers, and also the areas of Hooghly and Burdwan districts through which the dead rivers of Behula and Gangur pass and which lie to the South-east of the Burdwan-Katwa railway line, present a water table very near the surface. Also, there occurs very little change in its depth below surface, between the pre- and post-monsoon periods. Indeed, the conditions here are such that waterlogging may result. On the contrary, the area lying to the West and South-West of the same railway line possesses a considerably deep water table showing high pre- and post-monsoon fluctuations. Naturally therefore there is little likelihood of waterlogging occuring in this region.

The soil-texture of the Lower Reach of Damodar is not homogeneous, implying that the speed of movement of ground water must vary from one locality to another. The effect is that the piezometer readings take time to reach a steady state all over. The graphical study of such data for 1955 indicates that in the area under investigation, the rate of rise of water table is much faster than the rate of rainfall. The obvious conclusion is that the watertable gains by seepage from outside the area under consideration. There is another fact to be taken note of. The watertable of different areas is not found to respond to rainfall until the total rainfall in an area amounts to a specific minimum value. This fact straightway denotes that the surface run-off or drainage capacity of the different

areas of the Lower Reach must vary from area to area. Surface removal of water must be pretty considerable where rainfall need reach a level of 14 to 18 inches before the water table records a change. By contrast the drainage or surface run-off of an area must be very poor where only as much as 3 to 4 inches rain is sufficient to move up the watertable. These facts stress the importance of topography in relation to drainage capacity in waterlogging studies.

In this connection it has been noticed that the water table contours, as yielded by the 1955 data, show a slope from north-west to south-east. These contours are regular, and are widely placed during the pre-monsoon time. But they lose their regularities with the onset of monsoon. In moving from Arambagh to Baidyabati, it is noted that as the slope of the ground surface decreases, the watertable comes nearer the surface. Such occurence near Gopalnagar in fact presages a possibility of waterlogging in October i.e., after the monsoon. Further, as relief depressions occur along the fringe of the Bhagirathi, as also near the old and dead rivers, these areas too are pregnant with possibilities of waterlogging.

### Past Conditions

On examination of the data regarding the old and new courses of Damodar and its associated tributaries, it is easy to see that the greatest diversion of the Damodar course took place about the middle of 18th century through Kana Damodar, depriving the upper Hooghly river i. e., Bhagirathi, of a certain amount of its water supply. Of course, there is evidence that besides Damodar, its outfall rivers, Bhagirathi and Rupnarain have also shifted from their original course.

A close study of the course of Damodar in the Lower Reach, along with the courses of the other associated rivers, before the setting up of the embankment, i.e., between 1700 and 1850 A.D., shows that the flood water of Damodar had within this period been flowing alternately through its own channel and the channel of the Kana Nadi. The last big change was the opening of the Begua River in 1865, below Jamalpur. At present also, as we have seen in our earlier discussion most of the flood discharge of Damodar flows through this channel which is called Kaki river below Muchihana, and then proceeding through the Mundeswari Khal, the discharge falls into Rupnarayan River.

Besides the evidence of the past river behaviour, the swinging nature of the lower courses of Damodar is also supported by the irregular nature of sedimentation and formation of profiles; such changes in the river channel is a normal phenomenon in the deltaic condition.

The water of the Damodar channel at present is used mainly for irrigation upto Rashpur, while from Someswar onwards, it is used for drainage alone. However, the main drainage line of Damodar has shifted several times from the 16th century onwards, upto 1865 A.D., some of the earlier drainage lines ceasing to function with each subsequent change. These moribund drainage channels with very restricted flow have been utilised for irrigation by the adjoining villages. Irrigated areas have thus encroached upon the Banka and the Behula—Gangpur basins. The whole of the Kana Nadi and Kana Damodar basins which have lost their drainage water supply and become dry, with the later shifting of the drainage line of Damodar, are now held for irrigational operation under the D. V. C. Scheme. D. V. C. is also operating to excavate the dead and dying drainage channel of Damodar occuring to its left bank lying on the upper portions of the spill area.

A study of the drainage conditions in the Lower Reach, with reference to flood discharge siltaton and spill, clearly reveals that not only have there been several changes in the drainage lines, but also that the rate of decay of the drainage conditions has been hastened by monsoon, Besides the changes in the drainage condition, which have occurred from natural circumstances, man has also, by this construction of embankments and irrigation canals and adoption of flood control measures, interfered with the natural cycle of the Damodar river.

At present, good drainage conditions occur in the trans-Damodar area where the Mundeswari drainage line is operating. The D.V.C. Project has also effectively stopped the flooding and the on-rush of spill water of the existing drainage lines.

### History and Object of D.V.C. Project

Damodar has been a very troublesome river. To control its behaviour investigations were started from the middle of the last century. Earlier records (1850 to 1860) of the Bengal Government indicate how concerned the then engineers were about the condition and maintenance of the embankments. In 1843, the embankments of the lower Damodar were taken over by the Government from the local landlords. The first step which the Government took after taking over, was to strengthen the old bunds. The idea was to keep the river flow within the bounds of the two marginal lines of embankments. The history of the lower Damodar valley from 1843 to 1863 was thus the history of continued struggle between the river and the engineers. Embankments were breached every year at one place or another resulting in heavy economic loss. In order to relieve stress on the left bank and so make its strength adequate to withstand the onslaught of the turbulent stream, instructions were issued in 1863 to remove the embankment on the right side for a length of about 20 miles. Later on, in 1889 a further length of 10 miles was removed from the same embankment.

An important object of the measures taken in respect of the Damodar river, even today, is to control floods in the Lower Reach. The idea of flood control by means of reservoirs was indeed considered as early as the sixties of the last century. From 1864 to 1944, surveys of the Damodar basin were often carried out with the purpose of locating such storage reservoir sites Lt. Gernault carried out a survey with this end in view in January, 1864. This was later supplemented by the survey undertaken by Lt. Heyward in October, 1866. In 1902 Mr. Horn recommended a reservoir on the Barakar river just above its junction with the Damodar. In 1913, after the record-breaking flood of that year, Mr. Addams Williams recommended a reservoir at the site selected by Mr. Horn suggesting that if any practical difficulty arose, a site nearest to it upstream should be chosen. Mr. Glass in 1918 and 1919 suggested flood control dams at Parjori on the Damodar, at Palkia on the Barakar, and Chitro on the Usri. These sites were also recommended by the Flood Control committee of Bengal Government after the 1943 flood.

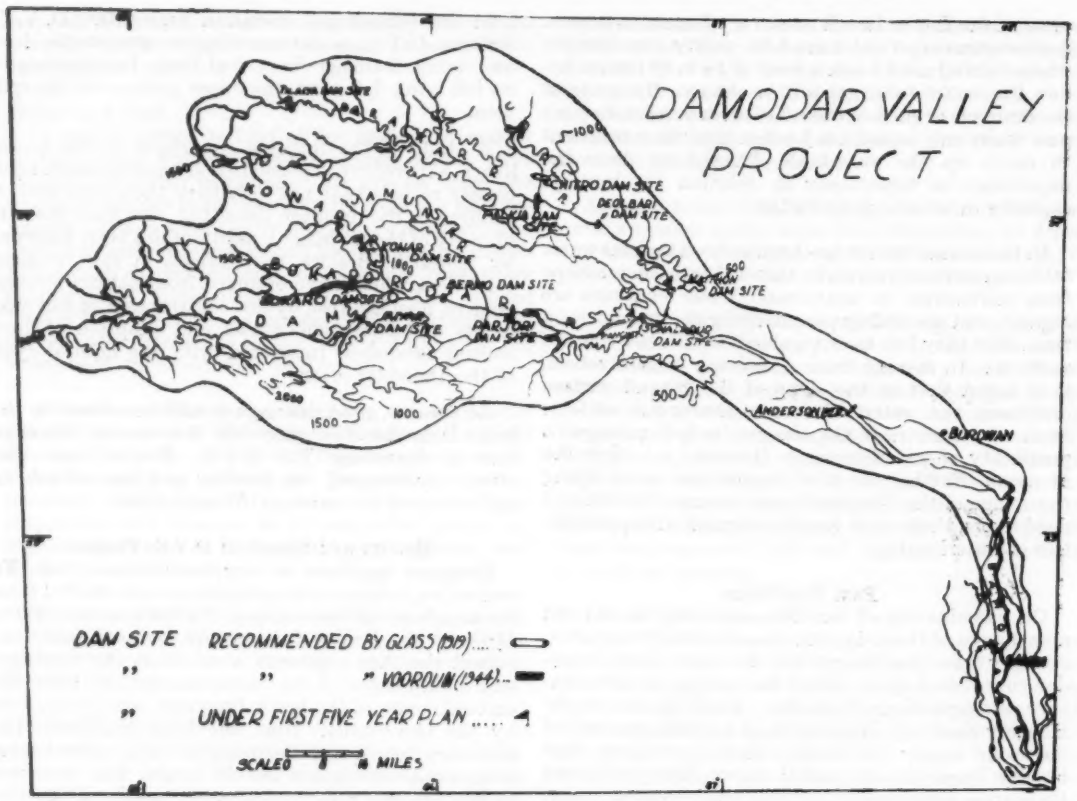


**Fig. 64**

In August 1944 Mr. Voorduin (American T.V.A. expert) submitted his report of enquiry and survey to the Government of India. The report was further examined by four experts appointed by the Government of India namely Messrs. Ross Reigel, Fred Schlemmer, A. N. Khosla and Narasimhaiya. The main technical features of the scheme were approved by Messrs. Reigel and Schlemmer and they recommended early initiation of construction work which was suggested to begin with at Tilaiya. The Tilaya construction was to be followed by one at Maithon after one season.

Following this, the D.V.C. came formally into existence on the 7th July 1948. The progress book of D.V.C. from 1948 to 1956 shows that its programme which may be described as being rather of dynamic nature than static, has in fact now moved far away from the original concept of Voorduin's.

The following chart will depict the scope of the D.V.C. project and the additions made to the scheme.

| *Mr. Voorduin's Plan* | *First five year plan* |
|---|---|
| 8 *Storage reservoirs* :— Maithon, Konar, Tilaiya, Sonarpur (near Panchet) Aiyar, Deolbari, Bokaro and Bermo. | 4 *Storage reservoirs* :— Maithon, Konar, Tilaiya and Panchet. |
| 8 Hydel stations, at each reservoir; generating capacity of hydel plants 2,00,000 KW | 3 Hydel stations-Maithon, Tilaiya and Panchet 1,04,000 KW<br>Bokaro thermal station 1,50,000 KW with provision upto 225,000 KW |
| Transmission system 132 K.V. lines—150 miles 132 K.V. grid stations 5 | 132 KV lines—720 miles, 33 KV ,, —91 ,, 132 KV. grid substations 15 33-K.V. receiving stations—14. |
| *Irrigation* :— Perennial irrigation to 7,60,000 acres (including 185,000 acres getting kharif irrigation from an existing system with a weir across Damodar | Kharif irrigation to 10,44,000 acres (including 185,000 acres getting kharif irrigation from an existing system) and rabi irrigation to 300,000 acres with a barrage across the Damodar.<br>Conversion of left bank irrigation canal (85 miles long) into a navigation cum irrigation canal with adequate locks, loading and unloading facilities.<br>Drainage of some 701 sq. miles of waterlogged areas in the lower valley. |

| *Mr. Voorduin's Plan* | *First five year plan* |
|---|---|
| | Soil conservation work in the upper valley, Anti-malaria work and miscellaneous development work. |
| | Second five year plan (additional schemes) |
| | Extension and strengthening of the transmission system. |
| | A 4th set at Bokaro with a capacityof 40,000 KW. |
| | A thermal station at Durgapur with a capacity of 1,20,000/1,50,000 KW. |
| | A number of headwater dams for soil conservation and irrigation. |

**Proposed D.V.C. Dam Regulations**

It is expected that the operation of the four dams would reduce the highest known peaks (650,000 cusecs) of flood discharge to 250,000 cusecs.

The Engineering office of the Damodar Valley Corporation in its Water Management Plans for Maithon and Panchet Hill Reservoirs (first stage of Development) December, 1951 has worked out the Water Balance account for Durgapur Pond during the years 1933-1950. The frequency distribution of daily average discharge at Rhondia for river flows above 20,000 cusecs for the seventeen years, from 1933-1950, has been worked out both for the natural condition as well as for the regulated condition, as proposed by the D.V.C. These are mentioned in Tables Nos. 46 and 47.

TABLE NO. 46

Frequency of daily average discharge at Rohondia exceeding 20,000 cusecs for 17 years (1933-50). Figures in bracket show the annual average frequency.

| *Class-Interval* | *Frequency* | |
|---|---|---|
| | *Natural flow* | *Regulated flow* |
| 20,000— 39,999 | 509 (29.9) | 413 (24.3) |
| 40,000— 79,999 | 379 (22.3) | 215 (12.6) |
| 80,000—119,999 | 95 (5.6) | 53 (3.1) |
| 120,000—159,999 | 25 (1.5) | 20 (1.2) |
| 160,000—199,999 | 9 (0.5) | 1 (0.06) |
| 200,000—239,999 | 7 (0.4) | 2 (0.12) |
| 240,000—279,999 | 5 (0.3) | |
| 280,000—319,999 | 1 (0.6) | |
| 320,000—359,999 | 0 | |
| 360,000—399,999 | 1 (0.06) | |
| 400,000—439,999 | 1 (0.06) | |
| 440,000—479,999 | 0 | |
| 480,000—519,999 | 0 | |
| 520,000—559,999 | 1 (0.03) | |

TABLE NO. 47.

Cumulative frequency of daily average discharge at Rhondia in a year.

| *Discharge in cousecs.* | *No. of days under* | |
|---|---|---|
| | *Natural condition.* | *Regulated flow (under DVC river control).* |
| 20,000 and above | 60.74 | 41.38 |
| 40,000 ,, ,, | 34.84 | 17.08 |
| 80,000 ,, ,, | 8.54 | 4.48 |
| 120,000 ,, ,, | 2.94 | 1.38 |
| 160,000 ,, ,, | 1.44 | 0.18 |
| 200,000 ,, ,, | 0.94 | 0.12 |
| 240,000 ,, ,, | 0.54 | 0 |
| 280,000 ,, ,, | 0.24 | |
| 320,000 ,, ,, | 0.18 | |
| 360,000 ,, ,, | 0.12 | |

It is noticed from the table that the bankful stage (discharge of 200,000 cusecs and above) will not be attained oftener than 0.12 day in a year. This means it will be reduced from once each year to once in every eight years or only for 3 hours every year. It is also observed that the gutterful stage (discharge of 100,000 cusecs and above) will not be attained oftener than 4 days in a year. A daily discharge of over 80,000 cusecs is brought down from 8.5 days to 4.5 days in a year.

**Effect of D.V.C Dam Regulation on the Flood Condition of the Lower Valley**

It is clear from the above that the river flow will be controlled considerably with the operation of the dams. Between Silna and Jamalpur, the river flow will be confined to within the gutter channel and will overflow the rest of the river bed between banks only

4 days in a year. It can also be seen from the observation of cross-section at different points that the flow is confined mostly to a gutter channel or two even within the banks. The gutterful stage discharge at different points of the river is below 100,000 cusec. (see Table No. 48).

*Discharge at Rhondia for bankful and gutterful stages at lower stations with proper lag (Discharge in cusecs)*

TABLE NO. 48

| *Stations* | *Discharge* | |
|---|---|---|
| | *bankful stage* | *gutterful stage.* |
| Silna | 276,000 | — |
| Jujuti | 210,000 | 98,000 |
| Edilpore | 208,000 | 104,000 |
| Palla | 220,000 | 80,000 |
| Jamalpur | 164,00 | 96,000 |

This reduction of flood days in the gutter channels under the post-dam conditions will favour the growing of rank vegetation. Such vegetation will naturally encroach on the gutters themselves as these will also be running always at low supply. The reduction of flood in post-dam condition will also reduce spill over the right bank.

Any disappearance of spill over the right bank will result in the hanas having water only for a few days in a year. However, in the bankful stage at Rhondia, when discharge is between 200,000 to 300,000 cusecs, a considerable amount of water flows through the hanas (see Table Nos. 30 to 34). A good amount of this water spills in bankful discharge stage at Rhondia. But only a negligible amount of water flows through the hanas when the recorded flow at Rhondia is below 60,000 cusecs. The Trans-Damodar area, under the pre-dam conditions, gets overflooded every year, and often from a number of floods, the duration on an average being about 22.5 hours per year. This is the duration of bank overflow. But the floodings in the countryside persist much longer even after the river subsides. But under post-dam condition this duration from spill over the right bank would come to be about 3 hours per year only. Flood flushing through the hanas would thus be stopped. Consequently the area would loose its fertility and become malarious as well. The possibility of such a deterioration in the Trans-Damodar area should be carefully examined and steps undertaken in time to counter-act them.

To-day the main flow of the Damodar river continues through the Kaki river which may be designated the right arm of the Damodar river. In passing over to Mundeswari, in the post-dam days, the flood amount in Mundeswari would be reduced, and this would affect the area. The result would be that the Trans-Damodar area would become drier from the agricultural point of view, day by day.

So, the problems in the post-dam days may be recounted as :—

*Problem I* :
The flood flow between Silna and Jamalpur would be confined to running through gutters, and consequently rank vegetation would grow up.

*Problem II* :
The flood flushing through the hanas would be stopped. It would reduce flow through hanas.

*Problem III* :
Non-occurrence of spill over the Trans-Damodar area will dispense with the top-dressing of the soil, i.e., to say, fertilisation of the land by spill will be checked.

With these problems confronting the great national development project it becomes essential to consider the possible remedies. Some considered steps to overcome the enumerated difficulties are suggested hereunder.

**Proposed remedies**

*Re : Problem I* :
It would be necessary to clear up the rank vegetation continually in order to keep the river bed free for water flow during monsoon. For this, some portions of the riverbed can be distributed for cultivation.

*Re : Problem II* :
In order to have some amount of flow through the hanas, the hanas can be so redesigned that the water from the gutter channel may be taken out to flush the area. In addition, the antimalarial measures should be taken.

*Re : Problem III* :
Flood water is necessary to flush the Trans-Damodar area every year from a sanitary point of view as well as from that of fertilisation of land by spill. The Moja Damodar, Harinakhal and Pyaratungi Khal in the Trans-Damodar have already become dry. The usefulness of flushing doses as proposed by DVC may be considered in this connection.

If a certain amount of water can be diverted into Harina Khal from Mundeswari by means of regulator this drier tract will then get water to some extent. The Moja Damodar also needs a regular supply of water in its channel. The surplus water of lower Damodar should not be given away because under the post-dam conditions, this channel would be likely to deteriorate further. Moreover, a good amount of water will be required for flushing the sluices on the left bank. If the Moja Damodar can be linked up with the Harina Khal, then Mundeswari will have a direct link with the Moja Damodar. In such circumstance the Trans-Damodar area will have opportunity to receive the fresh upland discharges of Damodar.

**Effect of D.V.C. Dam Regulation on the Drainage Condition of the Lower Valley**

To examine the drainage condition, below the bifurcation at Jamalpur, in the post-dam days, the discharges upto gutterful stage (upto 100, 000 cusecs) are needed to be considered. It is clear from the Table (see Table No. 49)

TABLE NO. 49

*Discharge at Champadanga for different discharges at Rhondia (lag allowed 24 hours)*

| *Discharge at Rhondia in cusec.* | *Discharge at Champadanga in cusec.* | *River level at Champadanga.* |
|---|---|---|
| 40,000 | 1,400 | 36.40 |
| 60,000 | 2,100 | 37.50 |
| 80,000 | 2,800 | 38.20 |
| 100,000 | 3,800 | 39.00 |
| 120,000 | 4,400 | 39.68 |
| 140,000 | 5,500 | 40.40 |
| 160,000 | 6,400 | 41.00 |
| 180,000 | 8,000 | 41.76 |
| 200,000 | 9,100 | 42.20 |
| 220,000 | 11,000 | 42.79 |
| 240,000 | 13,400 | 43.37 |
| 260,000 | 16,000 | 43,95 |
| 280,000 | 18,600 | 44.39 |
| 300,000 | 22,000 | 44.83 |

The maximum discharge that would flow down to the lower Damodar is 3800 cusecs (or 4000 cusecs approx.) at Champadanga for 4 days in a year. From our previous study it is seen that the lower Damodar is tidal upto Amta but it is not so at Champadanga. It is also seen from the previous study that this arm of Damodar channel at Mohiddipur carries the percentage of flood volume in different floods ranging between 2.3 to 4.8 when the flood volume percentage is considered to be 100 at Rhondia (see Table 21). Thus from observations it is clear that in post-dam days the lower Damodar channel may die, and to maintain the present condition the discharge of 4000 cusecs will be necessary more frequently than 4 days in a year. Due to reduction of flood flow in the main Damodar in post-dam days and the tide lockage in its tidal reach, a number of drainage channels in the Trans-Damodar area will be silted up, and their carrying capacity will be reduced considerably.

In the post-dam days, though the upland discharge would be greatly minimised, the regulated discharge would flow into the Hooghly river via. Rupnarayan. Consequently, there are possibilities of forming a vast spill area for the Hooghly tides in the Lower Reach of Damodar.

In this connection it is also to be stated that the Hooghly River Expert Committee of Government of India have stated that a discharge of 20,000 cusecs would be required to keep the salinity of the Hooghly river water within proper limits upto Budge Budge. It may be mentioned here that similar difficulties were encountered in the case of the Sacramento San-Joaquin river system in North California off the bay of San Francisco after the construction of Shasta Dam on the Sacramento river. The field data and model experiments carried out there have shown that a minimum upland discharge of 3500 cusecs was necessary to restore the original condition. This has been achieved by the construction of a subsidiary dam below the Shasta dam. A similar difficulty about increases in salinity in lower Damodar and Mundeswari channels may be experienced.

In the case of Damodar, the river splits up into a number of channels below Mohiddipur. The lower Damodar has got a number of sluices on the left bank, which regulate the irrigation and the draining of the areas. It is clear from the previous study that at least 200,000 cusecs of Damodar discharge should be present at Rhondia for the proper functioning of the sluices on the left bank of lower Damodar, and at least 8,000 cusecs should occur at Amta for the functioning of sluices on the Madaria Khal. It is also clear from Table 49 that the 200,000 cusecs at Rhondia will send 9,100, cusecs to Champadanga (when the slucies will operate) and this will be achieved for 3 hours every year in the post-dam conditions. This means that the sluices are likely to be seriously affected in the post-dam days. So, the problems are :—

*Problem—I :*
The lower Dam Channel below Mohiddipur may die unless proper steps are taken.

*Problem—II :*
The reduced Damodar discharge which will overflow into Rupnarayan will affect the tide absorbing capacity of the river. To what extent this will happen may be observed carefully before taking any steps.

*Problem—III :*
The reduced discharge will create difficulties about the operation of the sluices in Lower Damodar.

**Effect of D.V.C. Irrigation on the Lower Valley**

The Damodar-Bhagirathi inter-riverine plain is a low-lying triangular shaped area over-run by many dead and dying channels. The area is often waterlogged partly due to excessive floodings and partly due to tide lockage. Numerous canals have been constructed in this area which is on the left bank of Damodar. From the previous study, it is noted that frequently depressions occur in the area, whose levels do not allow them to be adequately drained in between two dry seasons by the surface drainage process. This, as it is, favours creation of water-logging. This waterlogging problem would be aggravated by seepage flow into the low-lying areas, particularly when the area is served by the numerous canals of the D.V.C. The regulated dry weather release from Tilaiya, Konar, Maithon and Panchet will provide a continuous flow of around 3000 cusecs.

The rise of ground water table is usually derived from three sources besides the direct one of rainfall :

(*i*) The irrigated tracts immediately over the ground water table. This factor will be operative in all cases in the Lower Reach of Damodar :

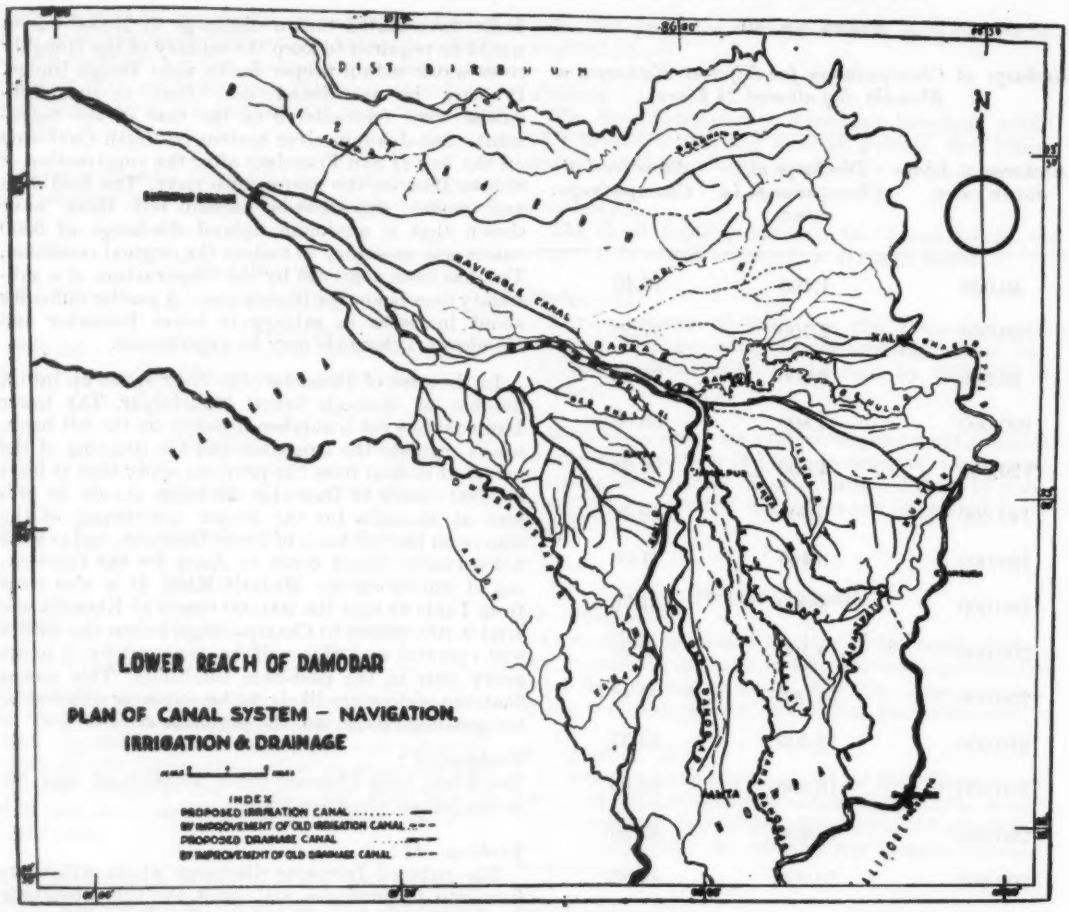


Fig. 65

(*ii*) The irrigated tracts some distance away from the locality where the ground water table is rising: and

(*iii*) The channel itself.

With regard to the area under investigation, the factors (*ii*) and (*iii*) are operative in those parts through which the navigation channel and the other canals pass.

In view of the above geographical and tidal features of this area generally described here as the inland deltas of the Damodar river, comprising of the districts of Howrah, Hooghly, part of Burdwan and Midnapur, it is essential that the pre-irrigation behaviour of the water table should be studied carefully. This investigation has already been undertaken by D.V.C.

The study on subsoil features has revealed the fact that the scattered clay pans of varying thickness infiltrate into beds of sand or silt over this deltaic region. This is likely to respond in a peculiar way to the rise of the water table. As soon as additional water will be put on the area, water table will start rising rapidly in the sand and slit medium where no clay pan exists, and come up very close to the ground level. With the withdrawal of the rainy season, if no Rabi irrigation is provided, the water level will go down in these areas. The rise of water table in the clay formations will be governed more by subsoil water pressure from the surrounding alluvium than by the supply of water from local rainfall and irrigation (54). These are danger spots. A close watch should be kept over the rise of the water table in these areas. Ofcourse, how far, and how soon, this water-table in the sandy areas will go down will depend on the out-fall conditions which are tidal, and also on the supply of subsoil flow from the upper reaches of the commanded zone. So the problem along with the suggested remedy, may be stated as follows :—

*Problem—*

The area has got possibilities of water-logging, particularly in the low pockets or relief depression.

*Remedy—*

There are two-fold remedies for it; on the one hand, the pumping which will probably be economically feasible in sandy areas may be used, and on the other, the low lying pockets may more profitably be turned into piscicultural ponds.

**Probable Economic Effects of D.V.C. Dams on Lower Valley**

The regulated water flow will, it is realised create important economic repercussions on the Lower Damodar Valley area.

*Continued on page* 30

# Nuclear Power Station at Berkeley

The Power Station which the A.E.I.-John Thompson Nuclear Energy Co.Ltd., are building at Berkeley will comprise two pressurised, gas cooled graphite moderated nuclear reactors each cooled by 8 gas circuits with associated gas circulators and heat exchangers, the steam generated being passed to a total of four turbo-alternator sets. It is intended for base load operation with a net electrical output of 275MW and all the plant has been rigorously designed to achieve the maximum availability consistent with an economic installation.

The basic design for the Station has been governed principally by the relationship of the three major units namely the Turbine House and the two Reactors. These units are arranged in a symmetrical pattern about a centre line and the smaller ancillary units are arranged in juxtaposition to the main units to suit the functions of the various buildings and to facilitate movement from one to the other.

The site is separated by an "active area fence" into two distinct areas. The first encloses those buildings which are connected with the nuclear portion of the Station, and the second encloses the conventional power station buildings, i.e., Turbine Hall, Administration Block and Workshops.

Within the active area there are two reactor units with associated irradiated fuel storage pond, decontamination building and active laundry. Access to this area is through a security gatehouse control point situated at the centre of the site. Within a very short distance of this point is the main control centre in the turbine hall.

A uranium fuel store building is provided within the inner fence but deliveries by road may be made through a special gate from the inactive area so that vechicles need not enter the active area.

The major axis through the turbine hall and between the two reactors is roughly parallel to the River Severn. The cooling water pumphouse is near the river bank, and the administration, workshops and general welfare unit is away from the river and overlooking the approach road into the site.

*Reactors*—Each reactor comprises fuel elements, graphite moderator and supporting steelwork, pressure vessel, shielding steelwork and shield cooling, charge and discharge machines and fuel handling equipment, burst fuel element detection equipment, control and instrumentation, including control rods and their operation mechanisms, gas storage facilities, gas main circulating ducts, main and auxiliary gas circulators and control steam raising units and all associated civil engineering work.

*Fuel Elements*—The design of the fuel element aims at ensuring that the irradiation period of the fuel will not be limited by the inability of the element to withstand the thermal and nuclear effect to which it is subjected.

The fuel elements will be short in length, and therefore robust, and will be individually supported in the channel to overcome the undesirable effects of creep which would result if the elements were stacked one on the other. The length of the elements will be such that creep occuring due to their own weight would be negligible.

*Graphite Moderator*—The graphite moderator design is generally based on that developed by the United Kingdom Atomic Energy Authority, for Calder Hall Power Station.

The structure will comprise a large number of individual vertical columns of graphite bricks and tiles, each column being 30 ft. high and individually supported through a ball-bearings assembly on to cross braced girders which transmit the weight of the structure to the "A" frames supporting the reactor pressure vessel. The complete assembly forms a thirty-two sided regular polygon prism with a vertical axis. Provision is made in the design for Wigner growth and expansion movement generally and equipment is included for initiation and control of periodic Wigner energy release operations.

The geometry and stability of the structure will be preserved throughout the life of the reactor by side restraints in the form of flexible bracklets.

The top of the structure will be surfaced by a number of cast-iron cap plates, which will protect the channel entrances and will act as channel guides for the fuel charging and discharging equipment. The burst fuel element detection pipes will also be located by means of these plates.

Special measures will be taken, both during manufacture and during final erection, to ensure that the necessary high standards of cleanliness are achieved and maintained within the pressure vessel.

*Pressure Vessel*—The pressure vessel containing the reactor core is a vertical cylinder supported on specially designed rocking feet to take up thermal movement. The techniques already established at Calder Hall for the fabrication of this vertical cylinder have been carefully studied and adapted for this particular installation.

*Shielding Structure*—The design of the shielding around the reactor main pressure vessel, gas ducting, blowers and pipework penetrating the biological shield will be adequate in material, geometry and construction to attenuate the radiation to a safe level.

The main biological shield will be of reinforced concrete 8 ft 6 ins. thick. The top shield will be in fact, approx. 11 ft. thick, but due to control rod equipment voidages, the effective thickness will be 8 ft. The inner faces of the biological shield will be air cooled by an induced fan system and protected from neutron bombardment by a steel thermal shield.

The cooling air will be filtered before being discharged from the fans into atmosphere by two steel chimneys which extend to a height of 240 ft. above ground level. The fuel element discharge chute will also be ventilated by this system. These chimneys and associated filters will deal with all gas and active or potentially active ventilating air in a manner compatible with the "Recommendations of the International Commission of Radiological Protection", as revised on the 1st December, 1954.

*Fuel Charging and Discharging*—The fuel charge and discharge equipment is designed to be capable of loading and unloading fuel with the reactor on load. This entails the inclusion of heavy

shielding on the machines to protect the operator from the potential radiation hazard.

The design of the machines is such that no parts are left permanently in the reactor and no electrical equipment is introduced into the pressure vessel. The guides and moving parts which are introduced into the pressure vessel are designed with simplicity and robustness as the main features.

Irradiated fuel will be carried in shielded coffins away from the reactor area and stored under water in special cooling ponds for the necessary decay period of 100 days, after which the fuel can be shipped to the chemical processing plant.

Replacement of faulty fuel elements is possible with the reactor at full load.

*Burst Fuel Element Detection*—The burst fuel element detection equipment will be similar in principle, to that used at Calder Hall but with detailed improvements. It is designed to detect and locate the failure if a fuel element can sufficiently early to allow removal of the defective element before any significant increase in activity in the coolant circuit can occur.

The principle of operation is to make use of the fact that two of the most abundant fission products, Krypton and Xenon, are gaseous and that these decay to form solid subsidiary products which are themselves radioactive.

Samples of the coolant gas will be drawn through tubes from each of the fuel element channels in the reactor, and passed, after cooling and mixing in groups of four channels, through a multi-selector valve to a filter which removes solid particles, including any radioactive foreign matter. Then they will be passed to an electrostatic precipitation chamber and finally returned to the main coolant circuit by a compressor.

In the precipitation chamber the solid products, from the decay of the gaseous fission products, will be collected and passed into a counting chamber containing a scintillation counter which measures the beta activity of the deposit. The electrical output of the counter will be counted and recorded and will initiate the operation of a visual or audible alarm in the event of excessive channel activity.

The scale of provision of instrumentation and control equipment is in accordance with the policy of maximum centralisation of control.

*Control*—The station will be operated from one central control room from which each reactor, its associated blowers and its turbo-alternators will be adjusted to maintain load at the desired level. With this system great economy in staffing is possible and rapid corrective action can be taken in the event of any fault occurring.

Starting of individual plant items will be carried out locally upon telephoned instructions from the control room engineer. Normal running having once been established, control will pass to the central control room.

Operating control positions will be provided in the central control room, in the gas circulator houses in each reactor building, and on the turbine floor in the turbine hall.

The main features of the reactor supervisory instrumentation provided in the central control room are as follows :—

(*a*) Continuous indication and recording of neutron flux.

(*b*) Continuous indication of :
- (*i*) Selected fuel element temperatures.
- (*ii*) Inlet and outlet coolant gas temperatures.
- (*iii*) Position of each control rod.

(*c*) Pre-selected periodic logging print-out of fuel channel activity by automatic typewriter initiated by digital computer system with magnetic drum memory storage.

(*d*) Comprehensive visual audible alarm system giving ample warning of the onset of a non-urgent fault condition.

(*e*) Automatic reactor shut-down system initiated by urgent fault conditions.

Electric and pneumatic telemetering systems will relay the readings of reactor insturments to the central control room. Gas circulators steam raising units and turbines will be provided with standard flow, temperature and pressure measuring instruments, with appropriate telemetering being employed where necessary.

The control of the Station output will be achieved by regulation of the reactor gas temperature.

Individual items of plant and auxiliaries having been started up and the control centralised as mentioned above, the reactor control rods will be slowly withdrawn with the gas circulators running at a low speed. The plant temperatures will then be raised at a controlled rate. When steam production has reached an adequate level, the turbines will be started up by the turbine drivers. At the same time, the steam raising unit steam pressures and control rod positions will be suitably adjusted by the central control room operator to maintain rates of rise of reactor temperatures at the desired level. The gas temperatures having reached normal, the gas circulator speeds will be increased as the turbines are loaded up.

The turbines will be frequency controlled, the load being changed by speeder gear adjustment. Reactor gas outlet temperatures will be maintained constant at all loads by automatic control of control rod position. Plant load changing is thus by blower speed and turbine speeder gear control only. Automatic control of the latter from H.P. steam pressure would permit single switch load control of the whole plant. To shut down, the control rods are run into the reactor in the normal way. Due to the cooling of the core and the decay of fission products, an output of heat will continue for a very limited period. In emergency the main gas circulators will be driven by D.C. auxiliary motors during the initial shut-down period, but after a short while the plant will be cooled adequately by the gas flow induced by natural convection.

*Gas Storage and Ducting*—Storage capacity will be provided on the site for sufficient gas to charge the reactor. The storage facility will consist of suitable tanks to contain liquid gas under pressure together with evaporators and other auxiliary equipment. The necessary pipework and valves will be provided to connect the storage tanks to the main gas ducts and various auxiliaries.

The main gas ducts will be of mild steel designed, manufactured and tested in accordance with B.S. 1500 severe duty where applicable. Flanged joints are reduced to a minimum, site circumferential welding being preferred because of the elimination of leakage risk. Access to all parts of the gas ducting after erection will be possible through suitably disposed manholes. To limit the continued accumulation of entra ined particles in the gas circuit, cyclones and ceramic filters will be by-passed across the main gas circulators. Drying equipment will also be incorporated in a similar way to maintain the moisture content of the gas within acceptable limits. Blowdown pipework and filters will be included to permit any section of the gas system to be discharged to atmosphere through the chimneys. Exhausting equipment will enable the air to be evacuated from the gas circuit before charging.

*Gas Circulators*—The gas circulators will be single stage axial flow machines driven by A.C. squirrel cage induction motors through scoop controlled fluid couplings.

Variation in the gas quantity handled by the circulator will be obtained by altering the speed. The speed will be determined by the slip in the fluid coupling which will be capable of variation by altering the position of the scoop. This will be operated by an electro-mechanical actuator.

A small D.C. motor will be incorporated to drive the circulator at a low speed and to provide a flow of cooling gas through the reactor in the event of A.C. failure. It will be designed to start automatically under these conditions.

The lubricating system will be divided into two parts comprising that for the fluid coupling and gear couplings and that for the seal and bearings.

A self-contained distilled water system in each circulator house will be used to cool the circulator lubricating oil and other reactor auxiliaries. The distilled water will in turn be cooled by the main circulating water.

*Steam Raising Units*—Each steam raising unit is designed to absorb the heat from the gas, generating and supplying steam at two pressures in two separate steam circuits.

The steam raising units will be fitted with forced circulation pumps enabling high heat transfer rates to be obtained with the increased velocity of the water and steam mixture in the evaporator sections. The pumps will be totally enclosed and of the glandless type.

*Turbo-Alternators*—The turbo generating plant of the station will be of well-tried conventional design with two turbines associated with each reactor.

Steam and feed conditions have been calculated to provide the maximum alternator output for the heat provided by the reactor. The governor gear is suitably designed to handle the steam generated by the steam raising units and to maintain as nearly as practicable the reactor coolant temperatures constant over a wide range of loads.

The steam turbine will be of the horizontal close coupled tandem compound mixed pressure impulse type.

Deaeration of the feed water is carried out in the condensor in which the tube arrangement is such as to reduce the oxygen content of the feed water to a minimum. The feed heating system will consist of two stages of feed heating and includes ejector heaters and gland heaters. Fluctuations in feed demand will be met first by a supply of water from a pressure head tank and subsequently by supplies from the large reserve feed tanks.

Provision will be made for condensing steam which is discharged from the high pressure and low pressure receivers on any of the following occasions :

(*a*) Initial tests on the reactor.
(*b*) Starting up and shutting down of plant.
(*c*) Emergency shut-down of turbo set or reactor.
(*d*) Shutting down of reactor.

*Electrical Equipment*—The method adopted for the supply of auxiliaries throughout the station is the development of the "Unit" system used in conventional Coal or Oil-fired stations. In this case the "Unit" consists of one reactor and its associated steam raising units together with the two turbo-alternator sets which it supplies with steam.

The Station will have two such units, each planned to be operated independently of the other. However, the arrangement is such that it is possible to run No. 1 reactor with Nos. 3 to 4 turbo-alternator sets and vice-versa.

The Station electrical distribution will have three main divisions as follows :—

(*a*) A.H.T. (6.6 kV) A.C. System—This will supply all motors above 150 H.P. and the various auxiliary transformers. Nothing less drastic than a busbar fault on this system can cause simultaneous shut-down of as many as four gas circulators. Only the extremely unlikely coincidence of a fault on the main transmission system and loss of both turbo-alternator sets, can cause loss of all eight gas circulators.

(*b*) A.L.T. (415.) A.C. System—This will supply all motors of 150 H.P. and below. It will be fed from the 6.6 kV. unit and station switchboards by means of stepdown transformers. It also will be designed to minimise disturbance through the reactor gas circulators under electrical fault conditions.

The auxiliaries associated with each turbine will be supplied from the corresponding unit switchboard. Thus in the event of one turbine being shut down the corresponding turbine auxiliary board can be shut down without interference with the other sets.

Auxiliaries common to all turbo-alternator sets and which will be required during shut down periods, are supplied from two turbine house boards fed from transformers from 6.6 kV. Station boards. Also from the turbine house boards will be supplied lighting, heating and power services.

(*c*) A 240 V.D.C. System—This supplies all essential auxiliaries and will be used for standby and control circuit purposes. The system is in three independent sections each supplied by its own battery and quite isolated from the other sections as follows :—

No. 1 Reactor house section.
No. 2 Reactor house section.
Turbine House Section.
The turbine house section will be of a conventional nature.

The reactor house sections will supply many other reactor auxiliaries in addition to the shutdown cooling for the reactor. Consequently the power requirements are very large and continuity of supplies so essential that no protection is included on the loads to the battery. To eliminate busbar faults, however, the positive and negative busbars are physically segregated.

The switchgear equipment throughout the station is of a current rating and a short circuit capacity in accordance with the appropriate British Standards.

*Circulating Water System*—The circulating water plant will follow conventional practice the details of design being dictated by the siting of the station.

The circulating water will be taken from and delivered to the River Severn and will pass through guard screens and intake tunnels to the pump house. The intake tunnels will feed main C.W. pumps which will be interconnected to provide a completely flexible system. These pumps will discharge into seperate culverts carrying the circulating water for each turbo alternator. After passing through the condensors this circulating water will return to the river through the outfall culverts of which there are four, one serving each turbo alternator. The system thus provides a straight through flow in which, under all normal operating conditions the velocity in the tunnels and culverts is such that silt is unlikely to settle.

The cooling water system for the reactor auxiliaries will be connected in parallel with the condensers of the turbo alternators. A.D.C. auxiliary pump will be installed in the pumphouse to provide emergency shutdown cooling for the reactor auxiliaries in the event of complete electrical failure in the station. Should, however, this D.C. auxiliary pump fail for any reason, the reactor will not suffer serious damage as the gas circulating system is designed to provide convention cooling.

*Safety*—The plant as a whole has been designed to afford the greatest possible measure of operational safety. Conventional parts of the plant have been designed within the appropriate codes of practice and where the working of conventional plant may affect the safety of the reactor a policy of duplication and increased reliability beyond normal practice has been followed.

The fullest use has been made of the reactor's inherent self-stabilising characteristic in order to obtain a simple and safe method of plant control.

The electrical supply to the important reactor auxiliaries has been designed to be largely unaffected by disturbances and faults so that the chance of failure of the auxiliaries, such, as for instance, the main gas circulators, will be very remote. The inertia characteristic of the circulators is such that under the worst fault conditions, i.e. complete failure of the reactor safety system concurrently with failure of all circulaters, the fuel element temperatures would not reach dangerous levels. Auxiliaries have been provided where necessary with standby units driven from a guaranteed source.

# Letter to the Editor

Dear Sir,

I have read with some concern your editorial remarks on page 28 of your January 1958 issue, on the question of the utilisation of irrigation waters. Whereas in my article, I have only indicated that the State Control ceases just where village water courses are taken off from irrigation channels for actual irrigation in the fields, I do not mean to suggest that only a Governmental organization could deal with the situation. Something has, however, to be done to check uneconomic and wasteful use of irrigation supplies, wherever it takes place.

In a paper presented by me on the occasion of the 3rd Plenary Session of the International Commission on Irrigation and Drainage on the subject of Internal Field Distribution of Canal Water, I had suggested formation of Co-operative Societies for the purpose, on the pattern of Indian Panchayats. These Panchayats could look after the maintenance of water courses, could effect equitable distribution of water on mutual understanding between different share holders, keepting in view the crop pattern and the condition of crops, so that canal supplies could be utilised to yield the maximum advantages to the crops. The Panchayats in India, as they are form the nucleous of all village activities. Irrigation being a vital subject, could be attended to closely and in details by the Panchayats. Such developments may bring about reduction in the state expenditure incurred on maintenance revenue of staff, and may even lighten the load of water charges, in general.

In this context, we cannot afford to lose sight of the fact that development process, particularly in the field of irrigation is always slow. Many of our irrigation systems showed productive and profitable trends only after an initial period of irksome anxiety and unremunerative performances. We should undoubtedly have a pre-planned preparedness for full utilisation of irrigation supplies as they become available, but our expectations should be based on a realistic basis. In the field of irrigation, pre-planned preparedness is not always effectively possible because water is the pre-requisite for any kind of demonstration instructions. Besides, there is inertia in human nature. It gets multiplied manifold, where it is linked up with age long traditions of illiterate and conservative human element. Our irrigation schemes, therefore, are no exception to the normal pace of development. This does not, however mean that all phases of a project should not progress co-oridinatedly and simultaneously, as we can never over-emphasise on that aspect of our plans.

Yours faithfully,

BALESHWAR NATH

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*Continued from page* 26

## Drainage Study of Lower Damodar Valley-VI

The Lower Reach of Damodar has contained agricultural areas for several centuries. In the early days, the drainage condition in these areas was unaffected by human action, and was therefore quite free and natural. With the shifting of the drainage channels of Damodar, it was even possible to extend irrigational practices to the decayed drainage lines. Indeed within the last 75 years, irrigation area on the left bank of Damodar has increased enormously, and at present it bids fair to extend further with the increased facility of irrigation following construction of the D.V.C. canals.

The main kharif crop of the area is Aman paddy which is confined to the southern side, particularly below Amta ; but Aus paddy is also found distributed over the whole area. The Aus area however is now gradually giving way to jute cultivation. Besides these, Boro and Rabi (mainly potato) cultivations are also observed. The previously inundated low lying area of the Trans-Damodar tract is now under limited cultivation of jute and Rabi crops. It is expected that in the post-dam days, the D.V.C. dams will provide a continuous supply in the dry season for the Rabi Crops.

About industrial set up also it may be pointed out that with the construction of the Durgapur barrage, many industrial concerns have already been busy about plans to establish various industries thereabouts. It is obvious that the industries situated in the Damodar Catchment above Durgapur will give out much waste matter like soluble salts and chemicals into the river. Other industrial pollution of water is also probable. Not only will such pollution of river water be likely to lead to the defertilisation of cultivated lands, but will also result in incidence of water-borne diseases in this area.

The settlement pattern in the Lower Reach seems to have been chiefly determined by the drainage conditions. Along the banks of the river there occur densely populated villages, the size and shape of such settlements being modified by occurrence of the flood conditions. The true drainage line type of settlement, namely, the linear type is found along Kana Damodar, Damodar, Madariakhal, Moja Damodar and Kana Dwarakeswar. Density of population is high along the flood plains as well as along the embankments of these rivers. Certain areas, like the one between Damodar and Dwarakeswar, exhibit modifictions in the general elongated pattern depending on the topography and occurrence of small channels in the neighbourhood.

The present settlement map will also naturally change with the reduced flood discharge in the Post-Dam days, and with the introduction of electricity, newly constructed roads and small industries in the lower Damodar Valley. A great future can therefore be envisaged for this area with the introduction of the D.V.C. dams and barrage in operation. It should be possible with careful study and initiation of preventive measures to counteract the likely evil effects that have been enumerated before. It will therefore be necessary to keep a careful watch over the development in the lower valley that will follow now.

**Reference**

(54) Bose, N. K. : Behaviour of Subsoil Water Table under a System of Irrigation and Drainage.

# Report on Chambal Project

The Irrigation and Power Team of the Committee on Plan Projects in its report on the Chambal Project, just published, has emphasized the economic benefit that would accrue, both to the agriculturists and the country, as a result of hastening the programme of utilization of canal irrigation in the areas of Rajasthan and Madhya Pradesh covered by the Project. It considers that the period of ten years for realizing the benefit of irrigation can be reduced to half, provided its recommendations relating to agricultural aspects are immediately implemented. With the advent of canal irrigation, says the Team, the present pattern of agriculture, which requires considerable improvement, will undergo a revolutionary change.

Giving some of the "dominant impressions" of the Team regarding the administration of the Project, the report points out the "inordinate delays" noticed in the implementation, by the States of decisions taken by the Control Board, and in the preparation of detailed estimates and schedule of rates. To remedy the situation in this regard, the report has made certain recommendations which would render the job of the Chairman of the Board a wholetime function.

The Team has proposed dovetailing construction of Rana Pratap Sagar Dam with that of the Gandhi Sagar Dam, accelerating canal construction and lining canals with lime concrete instead of cement concrete. As a result of these proposals the Team hopes to effect economies amounting to a crore of rupees in the construction of the Project.

The provision of lime surkhi concrete bedding in the canal reaches passing through rocky terrain, instead of cement concrete, would alone result in the conservation of scarce materials like cement as well as a saving about Rs. 15 to 20 lakhs.

The Irrigation and Power Team was set up with Shri N. V. Gadgil as leader in February 1957 by the Committee on Plan Projects of the National Development Council. The Team was entrusted with the task of conducting investigations on the Chambal and Lakkavalli Projects with a view to securing economy and efficiency in the utilisation of financial and other scarce resources.

The other members of the Team were Shri Lal Singh, Shri M. Narasimhaiya, Shri C. L. Handa and Shri G. N. Pandit. Shri D. S. Borker worked as Secretary of the Team.

The Team has discussed the agricultural problems under three headings: (*a*) Changes in agricultural pattern, (*b*) Serious problems already existing, and (*c*) Urgent steps to be taken for deriving maximum benefits from canal irrigation.

The Team thinks that with the advent of canal irrigation, the present pattern of agriculture, which requires considerable improvement, will undergo a revolutionary change. At present, the crop yields are poor and even the elementary principles of dry farming are not observed. Milk yield of milch-animals is disgustingly low on account of poor feeding and poor breeding. The area under cash crops is almost insignificant. In its opinion the future crop pattern would largely depend upon the extent to which the State Agriculture Department is able to solve the problems of agriculturists under altered conditions.

As regards the existing problems and their solution, the Team in its report, has discussed the measures to prevent water-logging, salinity and bad drainage, installation of tubewells, encouraging use of pumping-sets and avoiding accumulation of salts by proper culturable practices. The Report says that the levelling of land in many places in order to ensure maximum advantage from irrigation seems indispensable. The total area in each of the State requiring levelling is estimated at 15 to 20 per cent or about a lakh or lakh and a half acres. The total provision proposed to be made for this purpose is Rs. 30 lakhs for Rajasthan and Rs. 46 lakhs for Madhya Pradesh during three years recoverable from cultivators in 5 yearly instalments.

The Committee has suggested the removal of the wild "ber" bush infesting the land in most area coming under the Chambal Valley Project in both States. This would easily increase the yield by 2 to 3 maunds of foodgrain per acre on an average.

The report says that Horticulture industry has immense potentialities and can bring about revolutionary change in the agricultural economy of the States. There is also immense scope for the development of sugar industry although the present area under sugarcane in both States is very small. The favourable points are that there is fertile soil and good climate and there would be plentiful supply of canal water. In this connection, the Team has suggested the creation of "Sugarcane Belts" to concentrate cane cultivation in suitable areas.

The Team has recommended the construction of pucca roads simultaneously with canal construction. It points out that with the on-set of monsoon, most of the roads in the proposed canal area get out of order and villages remain completely cut off for months at a time.

Referring to the considerable area of culturable waste land in both the States, the Team suggests that the States may lease out these areas to progressive enterprising agriculturists for sufficiently long period, or start co-operative farming on these areas.

Estimates of expenditure for three years both recur-

ring and non-recurring, on various schemes proposed by the Team in the field of agriculture aggregate to Rs. 59.3 lakhs for Rajasthan and Rs. 57 lakhs for Madhya Pradesh, including the amounts recoverable from cultivators.

In view of the increasing value of lands, consequent upon availability of irrigation facilities, the necessity of a betterment levy is beyond any doubt, says the report. The main principle to be followed, it adds, should be to fix the betterment levy at half of the estimated increase in the value of land as a result of the benefits of irrigation.

Owing to the present financial difficulties in the country, the load growth in the Chambal region will not be as rapid (i.e. increasing five-fold in five years) as it was forecast earlier. Hence it is suggested in the report that foreign exchange expenditure on Rana Pratap Sagar Power Plant may be postponed but the civil works should be started in the Second Plan period. The works could be accelerated if any unforeseen development of new loads does come about earlier than now considered probable.

The proposed transmission system lay-out may be modified slightly, says the Report, so as to inter-connect with the Chambal grid the recently installed thermal power plants and those under erection presently, contributing an effective capacity of 34,000 kW.

The report recommends the installation of the fifth generation unit at the Gandhi Sagar Power Station. With this installation and in conjunction with the thermal plants, it says, it is possible to meet a system demand upto 120,000 kW. The addition of the fifth unit not only serves to meet the load demand in the interim period till additional hydro-capacity is commissioned in the region, but also provides spare generating capacity for all the three hydro-stations, namely Gandhi Sagar, Rana Pratap Sagar and Kotah in the ultimate stage.

The major handicap for the speedy execution of the electrical works appears to be the shortage of technical personnel. The Team has suggested that the Central Water and Power Commission may consider sparing for this Project some officers who, being familiar with the designs, could be of help to accelerate executions in the field.

For deriving early and maximum benefits from the sale of power that will be developed by the Chambal Project in successive stages of its construction, the Report says that it is essential that the State Electricity Boards of Madhya Pradesh and Rajasthan should co-operate very closely and plan on the full utilisation of the hydro power as it becomes available, based on short term power sales understandings between the two Electricity Boards. Power may be made available for all consumers who can make effective use of it irrespective of where they are, whether in Madhya Pradesh or in Rajasthan.

Pointing out certain drawbacks in the administration of the Project, like delays in the States' implementing decisions taken by the Control Board, the report recommends that the State Finance Secretaries should be *ex-officio* members of the Board and technical designs should be regularly subjected to check by an independent technical agency. It also says that an agricultural expert should be made a member of the Board or at least consulted regularly.

The Board, the Report, suggests, should set up a machinery for carrying out the main functions assigned to it.

The recommendations of the Team would mean a much greater burden on the Chairman of the Control Board than hitherto, rendering his job virtually a wholetime function.

The total development of the Chambal Project with all the three, dams, power houses and transmission lines, Kotah Barrage and canal system, was originally estimated to cost Rs. 77 crores. Out of this, the Gandhi Sagar Dam and its power-houses, transmission lines, Kotah Barrage and the canal system, intended to be completed up to the end of the second Five-Year Plan, were originally estimated to cost Rs. 48.03 crores. This figure is now revised to Rs. 63.59 crores in view of rising costs. The expenditure on the Project up to date is Rs. 14.62 crores.

The Project underwent several changes before it was officially sanctioned in 1954 though the work had been started in 1953. These changes were inevitable in view of the then existing princely States. No precise schedules of materials, technical personnel, machinery and equipment could be drawn at the commencement of the Project.

The Gandhi Sagar Dam and the Kotah Barrage are now expected to be completed by 1959 and not earlier as originally planned. Canals and distributaries are expected to be completed by 1962-63. The Team, however, feels that the period of completion of the canals could be advanced provided funds are made available.

On completion, the Chambal Project would irrigate 14 lakh acres of land and generate 210,000 kW of electricity. By the end of the Second Plan it is proposed to achieve almost full irrigation benefits and to generate a maximum of 92,000 kW of power.

In order to keep a check on the quality of work being done at the Project, the Report commends the practices followed on the Bhakra Project, that is, to appoint a special Inspection and Control Organization under the Chief Engineers so as to have an objective analysis of factors influencing quality of work.

Such critical assessments by high-power technical bodies are indeed extremely useful. This is the second report of the Team, the earlier one being on Lakkavali Project.

The recommendations in both these Reports have an underlying lesson for all river valley projects, namely that planning on an engineering level must go handin hand with those on the agricultural and social levels if full and quick benefits are to be reaped from such large Projects.

*Continued from page* 14

**Commissioning of Transformers**

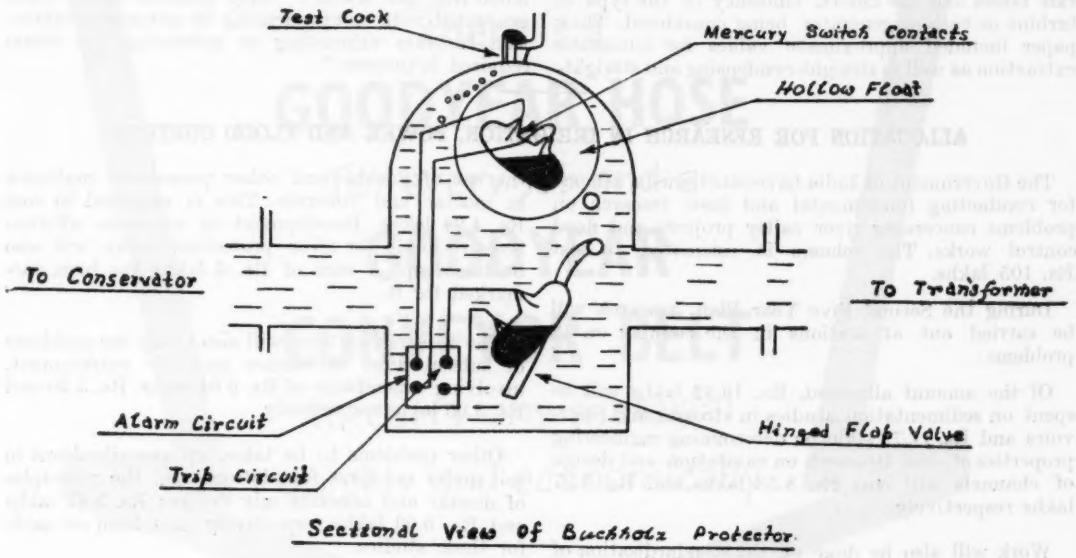


**Fig. 7**

operation of upper float of buchholz does not necessitate complete isolation of transformer.

*To test the lower float.* Oil is injected to the Relay at high pressure from a metal cylinder carrying an air pressure indicator and inlet valve suitable for coupling to a motor car type inflator and outlet valve to which is connected a rubber hose. The surge of oil will cause the 2nd of float of Buchholz relay to operate. It is to be checked whether operation of this 2nd float causes the trip circuit of the breaker to be energised. A typical relay operates when 300 cubic inches of oil per second flow through the relay.

**Final Survey**

*Check that*:

1. Normally open valves are open.
2. Normally closed valves are closed.
3. Conservator oil level check by dipstick only.
4. Silica gel breather plug is removed.
5. Silica gel colour is blue; if not empty the contents of the glass tube and heat on open pan at 300°F till it becomes blue.
6. All air pockets are cleared.
7. Terminal connectors are tightly fixed.
8. Connections transmit no pressure on bushings.
9. Thermometer Pockets are filled with oil.
10. All stains and foreign matter are removed from the bushing surfaces; use carbon tetrachloride; wipe off with chamoise leather.
11. No oil leaks are perceptibe.
12. Two earthing connections are made.
13. Neutral terminal is earthed.
14. Oil levels in the tap changing gear compartment is correct.
15. All grease nipples are greased.

(*Read at the Indian Science Congress, Madras*, 1958)

## PLAN STEAM, POWER SYSTEMS TOGETHER

Industrial plants which use both electric power and steam for processing can often achieve substantial savings in fuel and power costs by planning both systems together, two General Electric engineers told the American Power Conference.

W. B. Wilson and D. L. E. Jacobs, of the company's Industrial Engineering Section, outlined short-cuts for evaluating alternate methods of supplying steam and electric power for an industrial plant.

"Potential savings by proper selection of the steam and power cycle often go unrealised," they said in their paper, "because sufficient time is not allocated to make detailed step-by-step performance analyses when a new plant, a plant modernization, or a plant expansion is being considered."

They showed how eight or ten different combinations of power and steam systems can be compared on a preliminary basis, eliminating the least attractive, so that engineering effort can be devoted to detailed study of the promising possibilities.

They described a typical industrial plant which needed an automatic-extraction turbine to supply electric power and steam for processing. Short-cut evaluation methods showed that higher pressure and temperature for the inlet steam resulted in an annual fuel saving of almost $150,000 for each 10,000 kW generated. This saving is based on a fuel cost of 30 per million Btu and amounts to more than 1.6 mills per kw-hr., said the authors.

They showed how, for any selected steam condition

at the turbine inlet and at the exhaust point, the number of pounds of steam needed to produce a kilowatt hour can be calculated from theoretical steam rate tables and the known efficiency of the type of turbine or turbine-generator being considered. Their paper included approximate values for automatic extraction as well as straight-condensing and straight-noncondensing machines.

"Fuel chargeable to power is as low as 4,600 to 5,000 Btu per kw-hr.," they pointed out, "when generated with noncondensing or automatic-extraction turbines exhausting or extracting the steam required in process."

## ALLOCATION FOR RESEARCH IN IRRIGATION, POWER AND FLOOD CONTROL

The Government of India have sanctioned a scheme for conducting fundamental and basic research on problems concerning river valley projects and flood control works. The scheme is estimated to cost Rs. 105 lakhs.

During the Second Five Year Plan, research will be carried out at stations in the country on 12 problems.

Of the amount allocated, Rs. 19.82 lakhs will be spent on sedimentation studies in streams and reservoirs and Rs. 11.72 lakhs on determining engineering properties of soils. Research on cavitation and design of channels will cost Rs. 8.53 lakhs and Rs. 8.97 lakhs respectively.

Work will also be done on the standardisation of the use of Surkhi and other pozzolanic materials in mortar and concrete. This is expected to cost Rs. 4.94 lakhs. Development of economic alternatives to stone for river protection works will also be taken up. A sum of Rs. 6 lakhs has been earmarked for it.

The research stations will also study the problems of subsoil flow, turbulence and air entrainment, involving expenditure of Rs. 6.64 lakhs, Rs. 3.40 and Rs. 3.05 lakhs respectively.

Other problems to be taken up are vibrations in soil under machine foundations and the principles of mortar and concrete mix design; Rs. 3.87 lakhs and Rs. 5.03 lakhs respectively have been set aside for these studies.

# Our Contributors

*Mr. J. D'Sa* passed out from the College of Engineering in Bangalore in 1929. In 1930 he joined the University of Birmingham for electrical honours degree. After completion he joined as hydraulic operator at Sivasamudram in December, 1934. He was in charge of erection of two generating units at Shimshapura as well as of the low pressure penstock pipes and surge tanks. He led a team of engineers to England in connection with the testing of equipment for Mahatma Gandhi Electric Works. On return after 11 years he was at the Jog Falls, rising to the position of General Superintendent and was actively engaged in the installation of 11 Units installation of 120 MW. In 1955 he was posted as a General Superintendent of the Sharavati Valley Project. At present he is Chief Engineer Electricity, of the Mysore State.

*Mr. M. V. T. Iyengar*, B.E. is Deputy Chief Engineer, Major Irrigation (South) in the State of Mysore.

*Mr. R. N. Ganguly* graduated in Electrical Engineering from Bengal Engineering College, and was awarded Sibley Scholarship by the University of Calcutta. He had his practical experience with A.E.I.M. Co., Ltd., Southwales Electricity Board and British Electricity Authority. He served D.V.C. for several years. He also served Calcutta Technical School as Head of Electrical Engineering Department for a couple of years prior to joining West Bengal State Electricity Board.

*Mr. Satyakam Sen* concludes his series on the study of the Lower Damodar with this contribution.

*Mr. Ahuja*, the Director of Hydrology and Statistics in the Central Water and Power Commission, has been a frequent contributor to our journal. He last appeared in Vol. VII No. 9 our Special Number on West Bengal Power and Water Resources Development Symposium.

*Mr. C. K. Kochukoshy*, M.A. LL.B., is Assistant Director in the Hydrology and Statistics Directorate of the CW & PC and has been associated with the drafting of the Inter-State Rivers and River Valley Regulation and Developmet Bill. He is winner of the UN International Essay Contest, 1951.

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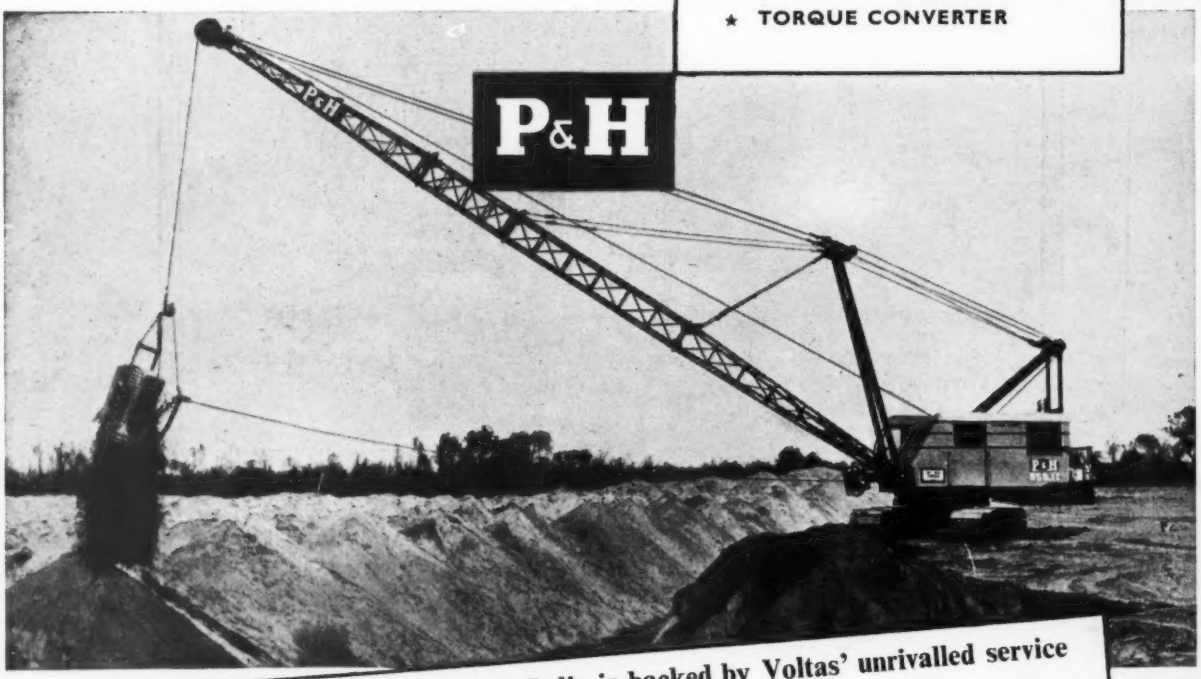


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